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FUELING THE HEAVY DIVISION USING THE PALLETIZED LOADING SYSTEM

A thesis presented to the Faculty of the US Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

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B.S., Western Kentucky University,
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1980

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The heavy division consumes vast quantities of fuel during offensive operations using AirLand Battle Doctrine. The current petroleum distribution system, using 5,000 gallon semitrailer tankers and heavy expanded mobility tactical truck tankers, is not designed to sustain the heavy division over extended offensive operations. The heavy division is an offensive weapon requiring fuel to reach its potential. This study examines the current problem of fueling the heavy division and provides a proposal for solving the problem. The solution is centered on using 7,000 gallon palletized loading systems (PLS) to replace the 5,000 gallon semitrailer tankers currently distributing fuel to the heavy division. The problem is addressed in terms relative to current AirLand Battle Doctrine, literature related to the problem, historical aspects of fueling operations, and current fueling doctrine. The proposed system is explained and is then compared to the current fueling distribution system. The analysis is qualitative in nature and is built around the framework of the offense (preparation, attack, exploitation, and pursuit). The study concludes that PLS is the fuel distribution system of the future due to its excellent mobility and its ability to get more fuel farther forward than the current system.

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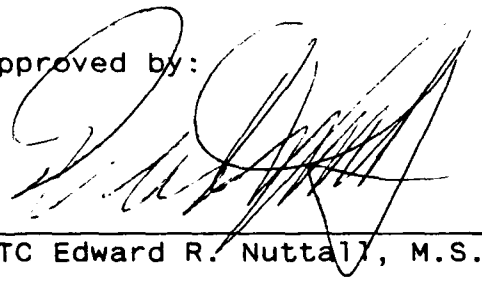

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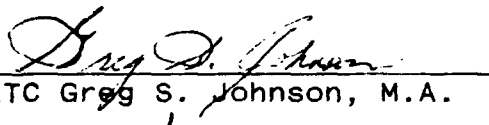

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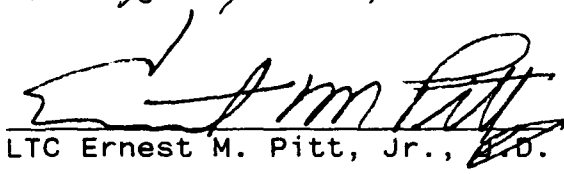

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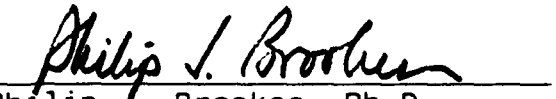

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

FUELING THE HEAVY DIVISION USING THE PALLETIZED LOADING SYSTEM by MAJ James M. Foster, 142 pages

The heavy division consumes vast quantities of fuel during offensive operations using AirLand Battle Doctrine. The current petroleum distribution system, using 5,000 gallon semitrailer tankers and heavy expanded mobility tactical truck tankers, is not designed to sustain the heavy division over extended offensive operations. The heavy division is an offensive weapon requiring fuel to reach its potential.

This study examines the current problem of fueling the heavy division and provides a proposal for solving the problem. The solution is centered on using 7,000 gallon palletized loading systems (PLS) to replace the 5,000 gallon semitrailer tankers currently distributing fuel to the heavy division. Through the process of the paper the problem is addressed in terms relative to current AirLand Battle Doctrine, literature related to the problem, historical aspects of fueling operations, and current fueling doctrine. The proposed system is explained and is then compared to the current fueling distribution system. The analysis is qualitative in nature and is built around the framework of the offense (preparation, attack, exploitation, and pursuit).

The study concludes that PLS is the fuel distribution system of the future due to its excellent mobility and its ability to get more fuel farther forward than the current system.

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In retrospect, I realize that this thesis is possible because of the support and assistance provided to me by several friends and associates.

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My good friend MAJ Roger W. McHenry provided me with the idea and initial encouragement I needed to start this study. Thank you Mac.

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CHAPTER ONE:

INTRODUCTION

The Army's role in our country is in a period of transition. There are many non-traditional missions being considered for the Army, but there is one mission which will not change. This is the Army's ultimate mission of deterring aggression and, should this deterrence fail, then close with and destroy the enemy on land. This thesis is about one small, critical portion of this mission: exploring a better method of fueling the heavy division.

I. Understanding the Problem.

The Army's current operations doctrine is centered on the AirLand Battle and appropriately named AirLand Battle doctrine. Army Field Manual 100-5, Operations, (FM 100-5), details the broad picture of AirLand Battle doctrine and identifies AirLand Battle Imperatives and Tenets. The doctrine explains what the modern battlefield looks like and what the Army must do to be the victor. The imperatives and tenets help communicate the doctrine and lay the foundation for all to follow.

AirLand Battle doctrine recognizes the importance of the operational level of warfare, focuses on seizing and retaining initiative, and insists on the need for multi-service cooperation.[1] The need to seize and retain initiative carries with it a focus on maneuver and offensive operations. Taking the fight to the enemy through maneuver oriented offensive operations requires forces that can move faster than the enemy (by decision and by weapon system). Maneuver, a principle of war, is essential to generating this combat power. At the tactical level it "contributes significantly to sustaining the initiative, to exploiting success, to preserving freedom of action, and to reducing vulnerability."[2] Consequently, movement is an essential element of this doctrine. Recognizing that most of our movement is not by foot but by vehicle is the first step in recognizing the inevitable task of fueling the force and its importance.

The AirLand Battle tenets are initiative, agility, depth, and synchronization.[3] Taking the initiative means controlling the tempo of a battle. It implies an offensive spirit when conducting any operation whether it is offensive or defensive in nature.[4] Movement (or maneuver) is essential to maintain this spirit and, of course, movement requires fuel. Agility is the ability to act faster than the enemy that includes physical, as well

as, mental qualities.[5] This ability to move quicker than the enemy includes not only maneuver units but support units, too. Maneuver units ability to operate without resupply is a finite period. The maneuver units can never move farther away than allowed by their "tails" (support units such as combat trains, field trains, direct support units, and general support units). Agility used to gain an objective is perhaps ill spent if the objective must be abandoned because support units can not reach the objective on time. Depth requires commanders to consider the entire battlefield when conducting operations. It also requires them to consider the next battle in addition to the one under development.[6] This includes understanding the resource requirements and knowing where to place critical supplies. Synchronization is perhaps the most difficult of the imperatives to achieve. It requires strong leadership, a well trained staff of planners, and disciplined operators. This is all required because the task is monumental: arrange "battlefield activities in time, space, and purpose to bring the maximum relative combat power at the decisive point."[7] For those providing fuel support activity centers on providing the right amount of fuel, to the right location, at the right time.

The AirLand Battle imperatives are -

Ensure unity of effort.
Anticipate events on the battlefield.
Concentrate combat power against enemy vulnerabilities.
Designate, sustain, and shift the main effort.
Press the fight.
Move fast, strike hard, and finish rapidly.
Use terrain, weather, deception, and OPSEC.
Conserve strength for decisive action.
Combine arms and sister services to complement and reinforce.
Understand the effects of battle on soldiers, units, and leaders.[8]

They are straight forward and simple to understand. They serve as guideposts that help all leaders and staff members understand what is critical for them to know as they perform their battle tasks. Below are those imperatives which impact greatly on fueling the heavy division.

"Anticipate events on the battlefield" requires logisticians who understand the tactical and operational aims of the battle. With this understanding logistical planners must predict the needs of the force. Fuel requirements must be predicted and then stocks must be positioned to maximize their use. Failure to anticipate heavy division fuel requirements and then to act accordingly has the potential to stop the division.

"Designate, sustain, and shift the main effort" requires fuel providers to respond quickly to changing priorities. Limited fuel stocks must move from one

location to another quickly and with little or no interruption of service. The movement may require using routes over unimproved roads which cut laterally across maneuver brigade areas of operations.

"Concentrate combat power against enemy vulnerabilities" implies the need to have fuel where and when the force requires. Failing to provide fuel at the proper time and place can cause friendly forces to not achieve this imperative. Concentrating combat power hinges on weapon systems with fuel and ammunition. A weapon system without fuel is quite worthless. They must have fuel to be effective and participate in defeating the enemy at the decisive point and time.

Keeping the heavy division fueled, while it conducts AirLand Battle according to these imperatives and tenets, is a substantial challenge.

AirLand Battle promises to be the most lethal battlefield human kind has ever experienced. The tenets and imperatives discussed above are the road map to success on this lethal battlefield. With this lethality comes confusion created by the mass of weapons, vehicles, and troops all crowded on the battlefield at once. Powering this mass of weapons, vehicles, and troops is our

battlefield operating system - combat service support. FM 100-10, Combat Service Support Operations, provides a general view of how to support AirLand Battle. This view includes sustainment imperatives (anticipation, integration, continuity, responsiveness, and improvisation) which complement the AirLand Battle imperatives.[9] To manage combat service support efficiently, FM 100-10 divides support into six sustainment functions: manning, arming, fueling, fixing, protecting, and transporting.[10]

Anticipation relates to the need for combat service support commanders to see into the future and plan for it while maintaining current operations. Integration refers to bringing support forces together with the combat forces. The support forces must be made part of the team, not a addition to it. Integration makes unity of effort a reality. Continuity is the effort of support forces to allow combat forces the ability to continue tactical operations. Slow-downs or halts due to logistical choke points are minimized when continuity is emphasized. Responding to changes on the AirLand Battlefield is the key element in responsiveness. Improvisation is a prerequisite for success on the AirLand Battlefield. Problem solving must consider innovative, unique, and, perhaps, eccentric solutions to critical problems.[11]

All of the sustainment imperatives have implications for fueling the heavy division. Anticipation, integration, continuity, responsiveness, and improvisation must be considered by both logistical planners and logistical operators. The imperatives are the common thread which ties the AirLand Battle imperatives and tenets together with the sustainment functions.

The sustainment functions are - manning, arming, fueling, fixing, moving, and protecting. Manning includes taking care of the individual soldier, as well as, providing fit soldiers to units. Arming centers on providing ammunition (Class V), while fueling's focus is providing bulk fuel (Class III (bulk)). Ensuring units have weapon systems and equipment available for combat operations is the goal of fixing. Moving encompasses getting people and equipment to the points of need and managing the resources involved in this task. Everything done to keep the sustainment system safe and functioning falls under the protecting function.[12]

During offensive operations of any size force, critical supplies are Class III (bulk) and Class V. Though each is important, fuel stands out as the most critical in conducting successful offensive operations.[13] The high rate of maneuver and advance during the offense places a

premium on fuel supply. Field Marshall Erwin Rommel, after his endeavors in North Africa from March 1941 to May 1943 with the Deutsches Afrika Korps, was well aware of the need for adequate supply support. The following illustrates his awareness of the importance of fuel.

> The first essential condition for an Army to be able to stand the strain of battle is an adequate stock of weapons, petrol, and ammunition. In fact, the battle is fought and decided by the quartermasters before the shooting begins. The bravest men can do nothing without guns, the guns nothing without plenty of ammunition; and neither guns nor ammunition are of much use in mobile warfare unless there are vehicles with sufficient petrol to haul them around.[14]

The modern heavy division (with six M1 equipped armor battalions and four M2 equipped mechanized infantry battalions) consumes an estimated 480,000 gallons of fuel per day during offensive operations.[15] These offensive operations include operating tracked combat vehicles about 15 hours per day, wheeled vehicles 62 miles or 100 kilometers per day, and stationary equipment about 12 hours per day.[16] For planning purposes, the combat service support system of the heavy division has a daily delivery rate of 428,000 gallons if two round trips per day are possible. This daily total includes 207,200 gallons delivered by the main support battalion and 220,800 gallons delivered by the three forward support battalions.[17] A deficit between the division's offensive requirement and

its distribution capability (52,000 gallons) is easy to see. When the heavy division conducts offensive operations this distribution shortfall detracts from the division commander's independence to prosecute AirLand Battle doctrine.

II. The Problem.

Of course, the preceding explanation of the shortfall is rather simplistic, but it reflects the distribution shortfall which reduces the division commander's tactical possibilities. Because of this inability to keep the heavy division fueled, the enemy will not feel the full destructive effect of our powerful main battle tanks and infantry fighting vehicles. Simply put, we (the combat service support leaders, planners, and operators) cannot keep the heavy division topped up with fuel during offensive operations.

III. Thesis Statement.

How do we (the U.S. Army) fix this problem? There are at least three approaches to this problem. One approach is to decrease the heavy division's requirement. This can be done by improving the division's fuel economy through research and development efforts or by various

other alternatives. Another approach is to increase supply. Increasing the distribution equipment and personnel in the system is one way of accomplishing this solution. A third alternative is to combine the first two approaches presented. Realizing that research and development is a long, slow process, I have chosen to attack the problem by increasing supply. My proposal is that the U.S, Army should use the palletized loading system (PLS) to provide fuel to the heavy division during offensive operations under AirLand Battle doctrine.

IV. Background.

Perhaps the greatest lesson learned from our most recent deployment and conflict, Desert Shield and Desert Storm, is that our logistics distribution system is broken. The U.S. Army accomplished its mission but it did so with much wasted logistical effort. General William G. T. Tuttle, commanding general of the Army Materiel Command, served as the Army's senior logistician during Desert Shield and Desert Storm. He confirmed that the distribution system is broken in the article he wrote for the November-December 1991 edition of the Army Logistician. About the current distribution system for repair parts he wrote,

> Unfortunately, in Desert Shield and Desert Storm this distribution system didn't produce the responsiveness required by AirLand Operations. . . We have done little to improve our distribution process since Vietnam, and we have seen similar - though not as poor - results on other occasions.[18]

This is an indicator of the total supply distribution system throughout the Army.

To satisfy its voracious appetite for ammunition the U.S. Army has approved PLS to supplement ammunition distribution. Using PLS to enhance distribution of other classes of supplies has been discussed but a decision has not occurred to use PLS in non-ammunition supply distribution.

Like the U.S. Army, the British Army has similar problems fueling their force. Their tactical distribution methods include using 20-liter jerricans to get fuel to main battle tanks and other weapon systems. Seeing the need to refuel their forces more efficiently, the British purchased the demountable rack off-loading and pickup system (DROPS). The system has a palletized fuel tank that is carried, off-loaded, and on-loaded using a unique prime mover and trailer with a hydraulic winch. Many sources consider DROPS a success and they have the system's superior performance in Desert Storm/Desert Shield for

proof. Illustrating this point are the remarks of the adjutant of the 8 Regiment RCT (Royal Corps of Transport):

> DROPS was a definite logistic success story. The robustness of the vehicle, the few mechanical problems, which were solved by the drivers and fitters, and the flexibility of the system were very impressive.[19]

V. Secondary Questions.

Before answering the thesis question, a few key subordinate questions will be answered in the process. These questions include: 1) How does our current petroleum distribution system work, and what are the system's strengths and weaknesses?; 2) Why hasn't PLS been implemented to improve petroleum distribution?; 3) What does the experience of other nations tell us about using PLS for petroleum distribution?; and 4) How can PLS improve the current system's weaknesses and exploit its strengths?

VI. Assumptions.

There are a few assumptions that are essential to this thesis. First, I have assumed that heavy divisions will continue to be a viable component of AirLand Battle in the years ahead. Second, heavy divisions will continue to consume fuel at current or higher rates. Third, U.S. Army

logistical planning factors for fuel consumption are accurate. Fourth, echelons above corps will always fill class III (bulk) requests from corps. Fifth, all ground and air requirements are met with one fuel: JP8. Last, the technology exists to put PLS to work in our petroleum distribution system.

VII. Limitations.

This study is not intended to justify or deny the PLS concept based on cost savings. My effort is to justify the concept for improving our fuel distribution capability without regard for cost in dollars.

VIII. Research Methodology.

The methodology used in this thesis is a comparative one. My analysis is based on the U.S. Army's current petroleum distribution system compared to my proposed PLS based distribution system.

IX. Key Terms.

The key term in this thesis is palletized loading system or PLS. For the purposes of this thesis PLS is a standard mobility heavy truck chassis, an integral,

hydraulic load handing mechanism, a compatible trailer, and special tankracks. The system is capable of self-loading and self-unloading the tankracks from the ground onto the truck chassis using the integral load handling system. The vehicle-mounted load handling system also can load and unload tankracks onto the companion trailer. (See Figures 1-1 through 1-4.)

Equipment terms appearing throughout this study include: 5,000 gallon semitrailer tanker and heavy expanded mobility tactical truck (HEMTT) tanker. The 5,000 gallon semitrailer tanker is the principal end-item the Army uses to distribute bulk fuel. This system includes a tractor and requires good roads for dependable service, hauls 5,000 gallons of fuel on the highway, and off-loads fuel using its on-board pump. The 5,000 gallon semitrailer tankers located in the division provide fuel on a retail or wholesale basis. The HEMTT tanker is a highly mobile, heavy duty truck with a 2,500 gallon tank capacity that can load and off-load its cargo of fuel. The HEMTT was designed for use over rough terrain in forward combat areas.

Class III refers to the category of supplies that include petroleum fuels, lubricants, hydraulic and insulating oils, liquid and compressed gases, chemical

products, coolants, deicing and antifreeze compounds, together with components and additives of such products and coal. Class III (bulk) refers to petroleum fuels in containers with more than 500 gallons fill capacity.[20]

The terms wholesale fuel issue, retail fuel issue, GS, and DS are common terms to combat service support soldiers but may be misunderstood by combat arms and combat support leaders and soldiers. Wholesale fuel issues are bulk issues of fuel from one storage container to another or a tanker truck to tanker truck transfer operation. An example is a bulk issue of fuel to supply units who in turn distribute the fuel to the fuel servicing tankers of using units. Retail fuel issues are issues of fuel to consuming vehicles. Whenever a HEMTT tanker dispenses fuel to M1 tanks or M2 infantry fighting vehicles a retail issue occurs. GS (general support) designates a support relationship whereby a unit supports another GS unit or a DS unit. Corps level petroleum supply companies and medium transportation companies (petroleum) provide fuel in a GS role to divisional support units such as the supply and services company of a main support battalion (MSB) or the supply company of a forward support battalion (FSB). The MSB provides GS when it provide fuel to the FSBs. DS (direct support) designates a support relationship whereby a unit provides support directly to using units. The

supply company of an FSB provides fuel on a direct support basis to the battalion trains of its supported brigade.

X. Significance of the Study.

This thesis will contribute another opinion on the use of PLS to enhance our fuel distribution capability in the heavy division. It will build on the existing literature and provide impetus for leaders justifying this as our distribution system for the 21st Century.

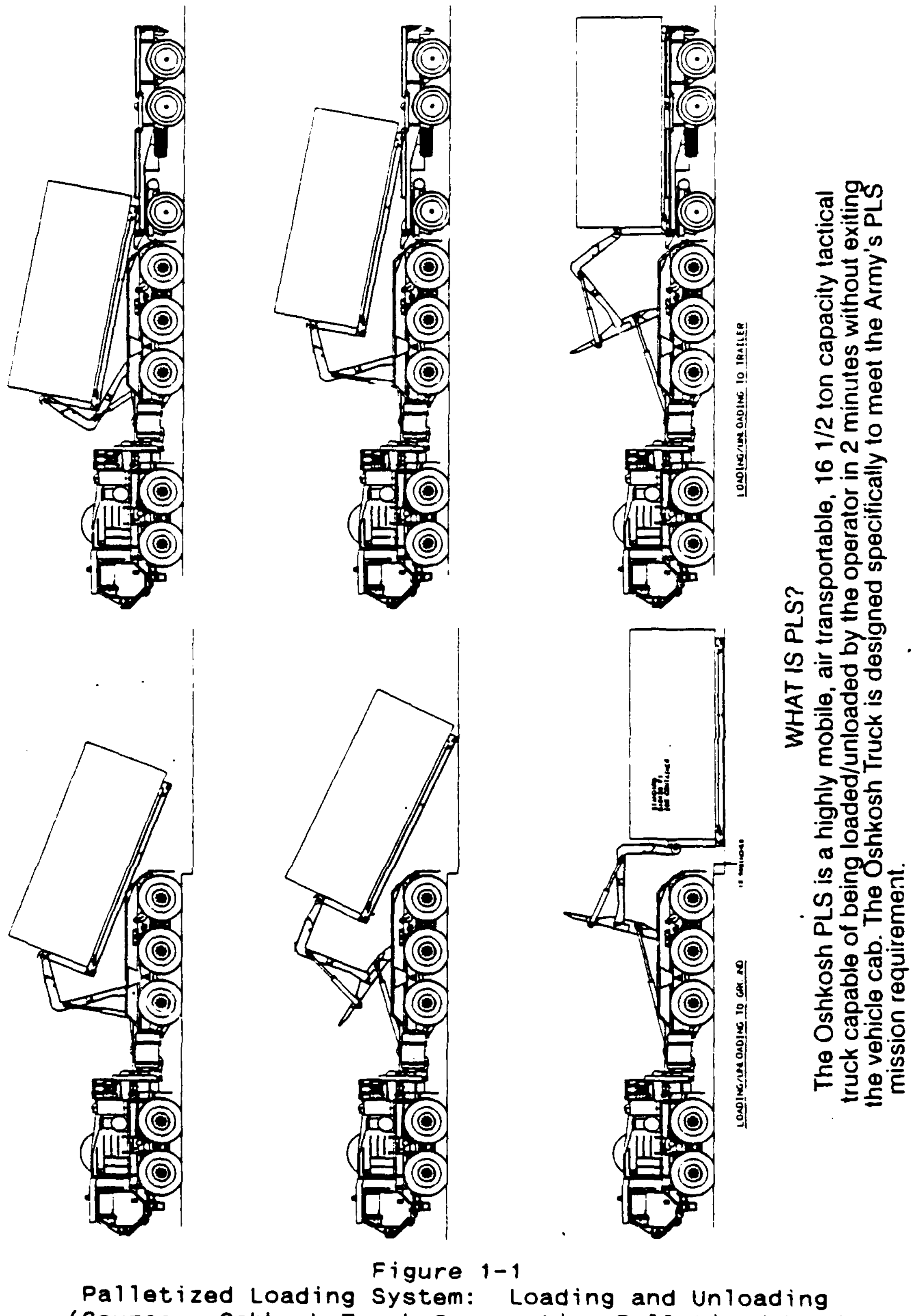

Figure 1-1
Palletized Loading System: Loading and Unloading
(Source: Oshkosh Truck Corporation Palletized Load System (PLS) Specifications, PLS-10-90. Released by Walt Garlow, Marketing Consultant.)

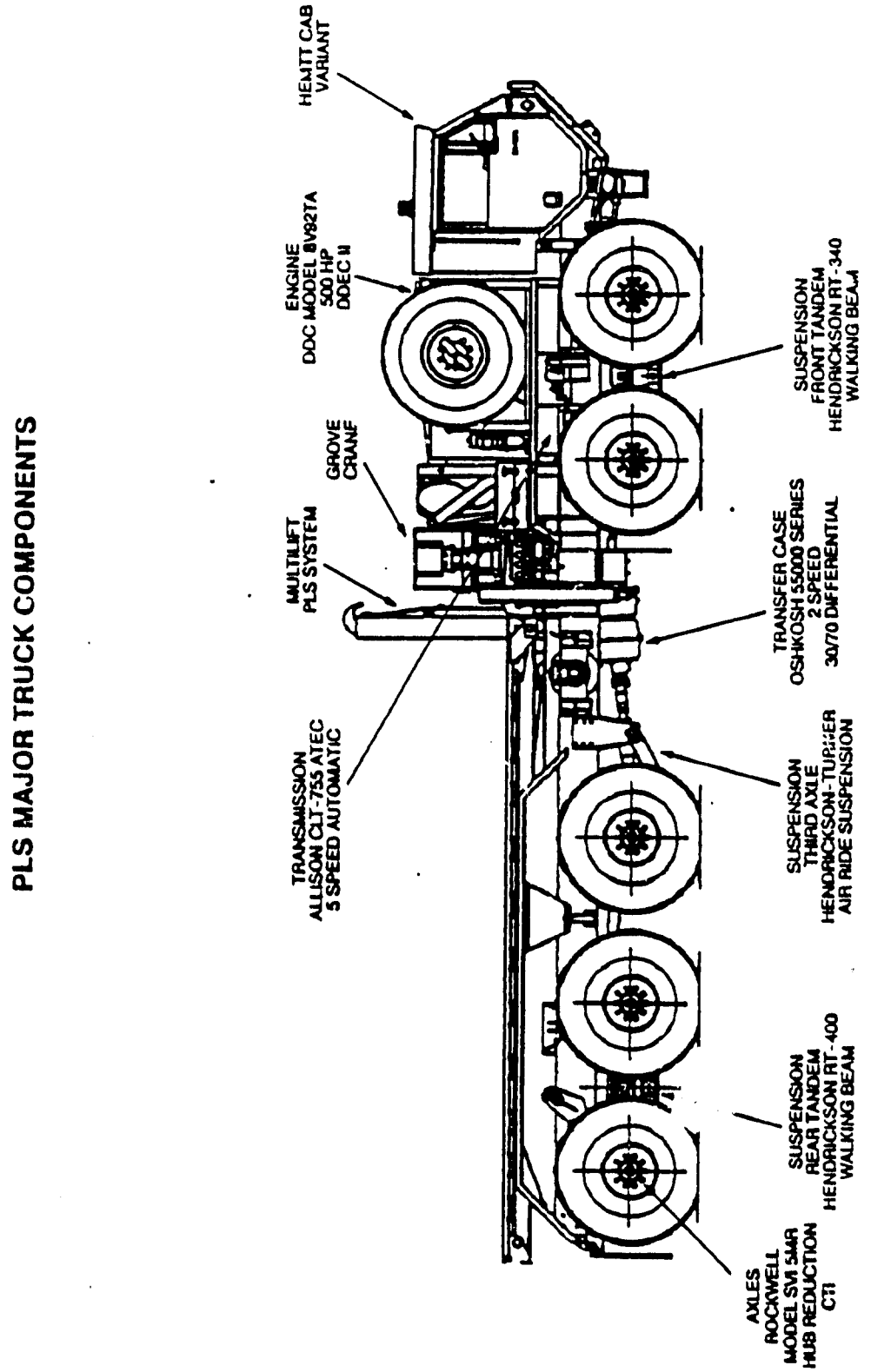

Figure 1-2
Palletized Loading System: Major Truck Components
(Source: Oshkosh Truck Corporation Palletized Load System (PLS) Specifications, PLS-10-90. Released by Walt Garlow, Marketing Consultant.)

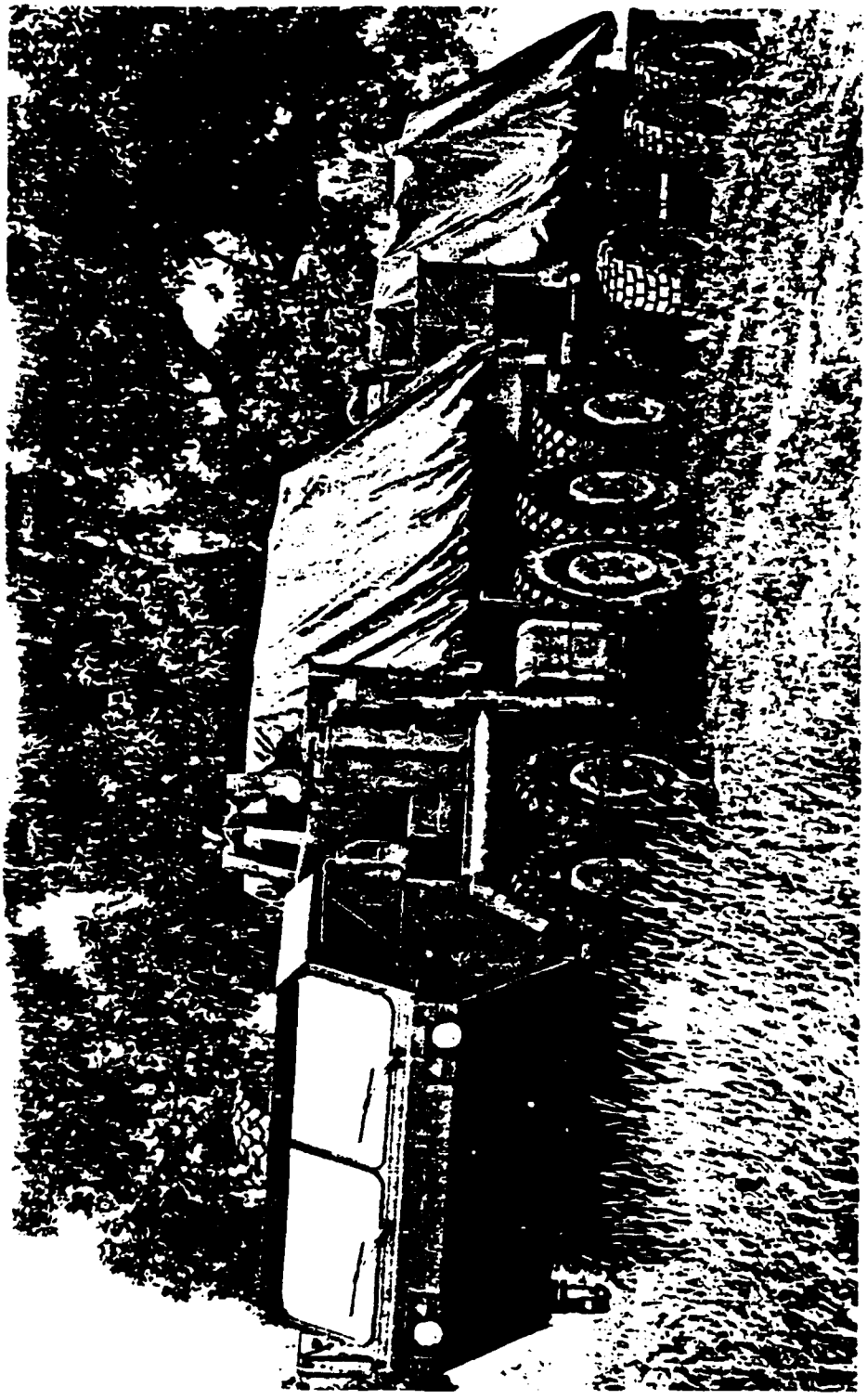

Figure 1-3
Palletized Loading System: Ground Level, Oblique View
(Source: Oshkosh Truck Corporation Palletized Load System (PLS) Specifications, PLS-10-90. Released by Walt Garlow, Marketing Consultant.)

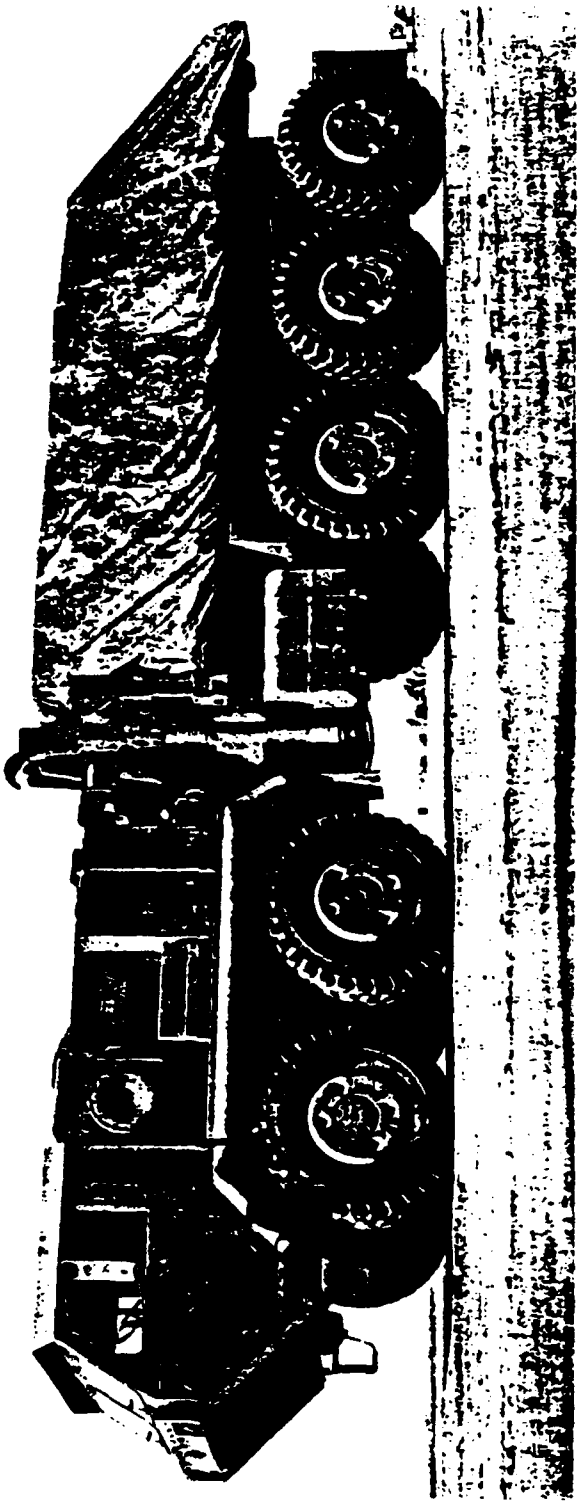

Figure 1-4
Palletized Loading System: Ground Level, Side View
(Source: Oshkosh Truck Corporation Palletized Load System (PLS) Specifications, PLS-10-90. Released by Walt Garlow, Marketing Consultant.)

ENDNOTES

[1]U.S. Army, FM 100-5, Operations, (Washington: Department of the Army, 1986),ii.

[2]FM 100-5 (1986), 175.

[3]FM 100-5 (1986), 15.

[4]FM 100-5 (1986), 15.

[5]FM 100-5 (1986), 16.

[6]FM 100-5 (1986), 16-17.

[7]FM 100-5 (1986), 17.

[8]FM 100-5 (1986), 23.

[9]U.S. Army, FM 100-10, Combat Service Support, (Washington: Department of the Army, 1988), 1-10.

[10]FM 100-10 (1988), 1-9.

[11]FM 100-10 (1988), 1-10.

[12]FM 100-10 (1988), 1-9.

[13]FM 100-10 (1988), 2-6.

[14]Van Creveld, Martin, Supplying War - Logistics from Wallenstein to Patton (Cambridge: Cambridge University Press, 1977), 200.

[15]U.S. Army, Command and General Staff College, ST 101-6, G1/G4 Battle Book (Fort Leavenworth: U.S. Army Command and General Staff College, 1991), 2-3.

[16]U.S. Army, FM 101-10-1/2, Staff Officers' Field Manual: Organizational, Technical, and Logistical Data Planning Factors (Volume 2) (Washington: Department of the Army, 1987), 2-54.

[17]ST 101-6 (1991), 5-6 and 5-13.

[18]Tuttle, Jr., William G.T., "Sustaining Army Combat Forces - Part II," Army Logistician, (November-December 1991): 12.

[19]Adjutant 8 Regiment RCT, "The Unique Scorpion Contribution to the War Effort, 8 Regiment RCT," The Review, (July 1991): 34.

[20] FM 101-10-1/2 (1987), 2-2.

CHAPTER TWO:

LITERATURE REVIEW

I. Introduction.

The purpose of this chapter is to provide you the current state of the literature on refueling the heavy division using PLS. When you have completed reading it you will know the key works and apparent trends in the scholarship.

As I searched for information on refueling the heavy division using PLS, I discovered little information on the specific subject of refueling the heavy division using PLS. Nonetheless, I located plenty of information related to the subject concerning refueling, PLS, and refueling using PLS.

In the following paragraphs I cover literature related to history, doctrinal publications, periodicals, and unpublished works. In addition, I cover the many discussions I had with professionals on the subject of PLS and fueling the heavy division. This provides a basic understanding of where we are regarding using PLS to fuel the heavy division.

II. Historical Books and Periodical Articles.

Historically, key ingredients to logistical, and refueling, successes were flexibility (of organization, men, and equipment), anticipation, and improvisation. This is true at all levels of war. Of the many books written about logistics, I have found none dedicated to the most critical element of logistics: fueling the force. Nonetheless, all the historical books I reviewed had at least something to say about fueling the force. All the authors tend to focus on the strategic and operational levels of fueling the force, yet very few wrote anything about tactical refueling. The authors seem to conclude that the U.S. Army in all conflicts since World War I through Vietnam had tactical distribution problems. The most well known of these problems occurred during World War II. During the summer of 1944 the Allies' offensive stopped for lack of the most precious of all supplies: fuel. Whether spelled out or hidden between the lines, every author emphasized the need for operational leaders to be well aware of their logistical capabilities and limitations. In addition, they also stressed the need to tie operational plans with logistical systems. In the following paragraphs I provide a glimpse into the books I reviewed and salient points the various authors make about fuel supply and distribution.

Supplying War - Logistics from Wallenstein to Patton (cited hereafter as Supplying War) provides examples of logistical problems in warfare from the mid-16th century through World War II. Refueling operations in World War I are ignored, while World War II refueling operations are limited to those related to the Allies' 1944 campaign across Europe. From 6 June until early September 1944 the Allies moved forward. On 2 September 1944 forward movement of the Third Army (US) (General George S. Patton's command) halted. Then within days First Army (US) stopped. They were essentially out of gas. The problem was not a lack of stocks on hand but a matter of where the stocks were and the lack of the force's ability to move them to the combat units. Distribution was the problem. The operators of the Red Ball Express did all they could to deliver supplies but they fell short. Supplies accumulated on the French shores but could not be moved fast enough or in large enough quantities to supply the voracious appetites of the Allies' equipment.[1] The author does a good job of explaining the problem and holding it up as an example of what happens when the logistical system cannot keep up with tactical operations.

The focus in Supplying War is on logistics at the operational level with some information on the strategic level. Failing to address tactical level petroleum

distribution, the book provided petroleum information aimed at the operational level. This translates into the author explaining how fuel accumulated on the French shore and the problems with moving it to the armies and corps.

For Want of a Nail: The Impact on War of Logistics and Communications (cited hereafter as For Want of A Nail) provides insight into the evolution of our current refueling systems. Refueling focus here is on World War I and the systems developed during the war. It is interesting that basic systems developed during World War I remain in use by modern armies today. Though tanker trucks, drums, and jerricans were used during the war, the tactical refueling workhorse of World War I was the 20-liter jerrican. Both Allies and Central Powers alike eventually used jerricans to distribute fuel forward on the battlefield. In fact, the British used captured German cans due to their availability, superiority, and durability. This is how the can received its English name: jerrican.[2] Jerrican distribution continues to be used by today's modern armies to provide fuel to their forward deployed forces.

For Want of a Nail provides a limited amount of information on fuel supply and distribution. The information it provides is interesting and may prove useful

to fuel planners at the operational and tactical levels. The tactical information on World War I refueling is especially interesting and helpful to student's researching military petroleum operations in a theater of operations.

The Lifeblood of War: Logistics in Armed Conflict is practical and full of insight. It is written in a way that befits a true warrior with an understanding of logistics. The author looks into logistics at every level from tactical through operational to strategic. He describes the logistical implications, problems, and lessons learned from several noteworthy operations. A recurring theme throughout the book is the need to tie operations and logistics together. One can logically deduce that since offense is the most demanding operation for fuel usage then synchronizing fuel support to the operation is critical. The author addresses refueling operations at all three levels while stressing flexibility, anticipation, improvisation and interoperability.

The author praises the Soviet's logistical performance during the Afghanistan War. He cites Soviet flexibility to adjust their supply priorities and their logistics organization as the main ingredient in their logistical success. The Soviet's doctrine focuses on the offense and fuel is critical yet it is not the most

important class of supply to them. Though the Soviet's were not able to wage war according to their espoused doctrine, they were able to meet the needs of the situation. Because of the nature of the war, the Soviet's adjusted their supply priorities to make fuel the most important. The vast emptiness of the country made them change their logistics structure to meet the huge demand for supplies. Almost every item they used while in-country had to be brought in through the supply system.[3]

The author recounts the struggle the British had with retail issue of fuel during the Falklands War. The British Army suffered from the same problems the U.S. Army suffers from: not enough forward distribution capability. The author explains the British problems with filling jerricans fast enough, moving jerricans from ship to shore, having enough jerricans, and not having trained soldiers to complete petroleum specific tasks (i.e., operating petroleum pumps, testing product, and safety procedures). Luckily, fuel distribution problems did not keep the British from meeting their strategic objective.

In addition, the author takes time at the first of the book to critique the two great war theorists and strategists, Clausewitz and Jomini. The author declares

that Clausewitz provides more insight into logistics on the modern battlefield.[4]

The Sinews of War: Army Logistics 1775-1953 is a volume of the Army Historical Series. As such it reviews and analyzes U.S. Army logistical strengths and weaknesses from the Revolutionary War through the Korean War. The book focuses on lessons learned primarily at the operational and strategic levels while spitting out numerous facts and figures. Divisional level petroleum logistics are not addressed. It provides only limited insight into the problems the army faced with the invention of the internal combustion engine. I expected more from this book on the most important class of supply in modern offensive operations.

Logistics in World War II - Final Report of the Army Service Forces is a 1947 report provided to the Under Secretary of War and the Chief of Staff by the Director of the Service, Supply, and Procurement Division, War Department General Staff. This is the U.S. Army logistics almanac of World War II. It is a historical reference book providing a consolidated list of all logistical data from World War II. Additionally, it serves as a comprehensive list of lessons learned focused on the strategic level. There is limited discussion of operational level logistics.

It emphasizes the need for standardized organizations/ systems and established doctrine for all units by type. Here again, emphasis focuses on the need to tie operations and logistics together.

A History of United States Military Logistics 1935-1985 addresses military logistics from the pre-World War II era through the post-Vietnam era. The author's petroleum focus is at the strategic and operational level though he does provide some information on tactical petroleum distribution during the Vietnam War. Throughout this work the author provides interesting information on logistics during this fifty year period. In his epilogue the author points out the need to tie operations and logistics together. Though not in-depth, the book does provide a good overview of how fuel was provided to operational and, sometimes, tactical units during the period's conflicts. This is a good book for those interested in beginning to learn more about the history of logistics during the period covered.

What do you want to know about petroleum supply and distribution in the Korean War? Well, Lieutenant Colonel Smith wrote a fact filled article on the subject for the November-December '51 edition of The Quartermaster Review. Lieutenant Colonel Smith was responsible for overall

petroleum supply in Korea for an unspecified time during the first 18 months of conflict. The article touches on everything from strategic to tactical petroleum supply and distribution.

As in all other confrontations the U.S. participated in since World War I, fuel supply at the strategic level was adequate. Though there were initial problems with the supply of aviation gasoline and jet fuel, the problems were remedied. The real petroleum distribution problems were on the Korean peninsula. Getting fuel from the communications zone to the front line was hampered by the lack of adequate infrastructure (particularly pipelines). Here again, tactical distribution relied on strong backs to handle fuel filled 55-gallon drums and five-gallon jerricans. Drum filling occurred as far away as Japan and the United States. Though the article only covers the first half of the Korean War, it provides insight to the problems encountered, their magnitude and improvisation used by the petroleum community to overcome them. Lieutenant Colonel Smith's personal insight and positive attitude come shining through in this interesting historical article.

III. Doctrinal Literature Review.

This doctrinal literature review includes selected U.S. Army field manuals (FMs) that dictate how we fight and how we support the fight. More importantly, they provide the doctrine we use to conduct offensive operations. Also included is an excellent professional bulletin article written by an expert on U.S. Army petroleum supply and distribution.

The Army's keystone warfighting manual is FM 100-5, Operations. It provides explanation and reasoning for how the Army fights through the entire conflict spectrum. The emphasis is on combined arms and combined service operations. The importance of offensive operations is linked to seizing and retaining the initiative. Sustainment planning and execution are addressed and the difficulties with sustainment during the offense are highlighted. Stressed throughout the manual is the need to synchronize logistical and operational activity. Leaders are provided with AirLand Battle tenets and imperatives and sustainment imperatives and functions to guide their decisions and activities.

While FM 100-5's principle focus is the warfighter, FM 100-10, Combat Service Support, focuses on the Army's logisticians. It expands on the combat service support of maneuver and combat support forces during AirLand Battle. It provides the overarching doctrine that serves as the basis for specific functional doctrine. Emphasizing the need to coordinate and synchronize logistical operations with combat and combat support operations, FM 100-10 identifies supporting the offense as resource intense and fuel as the supply in the greatest demand during the offense.

FM 71-100, Division Operations, applies the AirLand Battle principles to the division. Emphasis is on the principles which division level planners must consider when developing plans and orders. Offensive operations are explored in depth and the logistical considerations of the division are discussed in each type of offensive operation. Tactical operations are the focus of this manual yet it does not leave out a critical element of tactical success: sustainment planning and execution.

FM 71-3, Armored and Mechanized Infantry Brigade, supports FM 71-100 and applies the doctrine found in FM 71-100 to the brigade level. Combat service support is identified early in the manual as key to the brigade

conducting successful operations. Combat service support encompasses an entire chapter. It addresses combat service support considerations for the offense in an easy to follow checklist type format. Combat service support considerations are included in the doctrine for synchronizing offensive operations and is covered as one of the battlefield operating systems (BOS).

FM 71-2, The Tank and Mechanized Infantry Battalion Task Force, applies the concepts found in FM 71-3. It expands on the doctrine and provides comprehensive information on battalion task force operations. As found in FM 71-3, an entire chapter explains combat service support at this level. It provides lots of helpful bits of planning information. As FM 71-3 does, it addresses combat service support considerations in the offense as a component of the BOS. This can be a tremendous tool for the battalion task force planner.

The orientation of FM 10-67, Petroleum Supply in a Theater of Operations, centers on operational level petroleum supply and distribution. It addresses petroleum supply and distribution systems and associated organizations. Developed and undeveloped theaters are discussed with most of the focus on undeveloped theaters. FM 10-67 also covers quality surveillance, safety, security, and

rear area protection. Appendices include useful information for the theater level and contingency corps level petroleum planners.

Though written before release of current editions of FM 100-5 and FM 100-10, FM 100-67 complements the ideas and doctrine espoused by both. FM 10-67 points out the leadership of the Army in providing the theater with bulk petroleum products and the inherent coordination required with the Air Force, Navy, and Marine Corps.

FM 10-67 is out of date due to equipment and organization changes that have occurred since its release. Heavy expanded mobility tactical truck (HEMTT) tankers and main/forward support battalions are two of the changes needing integration in an updated FM 10-67. Despite these shortcomings, the basic principles are sound and still apply.

FM 63-3J, Combat Service Support Operations - Corps, covers how corps units provide combat service support and their normal organization for doing so. Though published before the current FM 100-5 and FM 100-10, FM 63-3J addresses the basics found in both and complements them. Fuel consumption in the offense is identified as high and a need to build up stocks in forward areas is identified.

FM 63-3J ties together combat arms and combat support operations with combat service support functions. With respect to bulk petroleum supply and distribution, the manual covers - the concepts of providing support in the covering force area, main battle area, and rear area; and the role of the corps support command (COSCOM), COSCOM materiel management center (MMC), petroleum supply battalion, theater army petroleum group, supply and service companies, and division MMCs. Throughput from corps to division brigade support areas (BSAs) is mentioned but not emphasized.

FM 63-3J provides broad guidance on petroleum supply and distribution operations giving the petroleum planners plenty of latitude. This type of guidance allows the planners what they need to build a responsive petroleum supply and distribution system tailored to the corps' needs.

FM 63-2, Division Support Command, Armored, Infantry, and Mechanized Infantry Divisions, provides the doctrine for how these divisions support themselves and their interface with higher echelons of support. A separate, comprehensive chapter covers petroleum distribution in the division. The increased fuel consumption during the offense is pointed out and serves as one of many

points to consider when planning sustainment of the division during the offense.

FM 63-20, Forward Support Battalion, and FM 63-21, Main Support Battalion, incorporate the most recent information found in FM 100-5 and FM 100-10. The clear emphasis in these manuals is on tactical level logistics integrated into tactical plans.

Petroleum distribution is addressed on a more step-by-step basis than previous manuals mentioned. These manuals provide defined methods of how fuel gets to the customer units. Yet, they allow the support battalion planners/operators to apply the concepts with initiative to accomplish specific missions. They discuss fueling considerations such as how to meet increased consumption in close and deep operations. Also, the reader gets a view of how the support battalions interface with COSCOM and DISCOM MMCs. Current equipment/concepts addressed include the use of HEMTT tankers, refuel-on-the-move methods, and the conversion of units to JP8.

FM 101-10-1/2, Staff Officer's Field Manual - Organizational, Technical, and Logistical Data Planning Factors (Volume 2), is the planners' source book for assistance with determining requirements in the following

areas: engineer, supply, transportation and movement, personnel service support, health service support planning for evacuation and hospitalization, and operational forces. Published in 1987, and updated with chemical defense equipment related information in 1990, this manual "incorporates the latest developments and changes available to support AirLand Battle doctrine."[5]

The petroleum consumption data and equipment usage factors provide planners with sound information to calculate bulk fuel needs. Naturally, unit equipment and mission or personnel strength must be known to make calculations. Though the data does not include JP8 consumption or L-series table of organization and equipment (TO&E) information, it remains a firm starting point for planners at all levels calculating bulk fuel requirements.

Colonel Dacey, as Chief of the U.S. Army Quartermaster School's Petroleum and Water Division, wrote an excellent article for the Spring '89 issue of the Quartermaster Professional Bulletin. It pulls together the current thought and doctrine on petroleum distribution and supply. Colonel Dacey gives a good overview of the system. Who better to explain it than himself, as the Army's chief educator and doctrine developer on the subject.

IV. Key Works.

The key works about using PLS to provide bulk fuel to tactical units include a U.S. Army Training and Doctrine Command analysis, dated 26 March 1990, and an Army Logistician article that offers PLS as a possible solution to current distribution problems.

"Class III Bulk Petroleum Distribution PLS Application," produced by the Directorate of Combat Developments, U.S. Army Quartermaster Center and School as a part of the "Palletized Loading System Follow-On Analysis (Final Report)," produced by the U.S. Army Training and Doctrine Command, Fort Monroe, Virginia and the U.S. Army Transportation School, Fort Eustis, Virginia, dated 26 March 1990 (cited hereafter as the PLS Follow-On Analysis) is the key scholarly research paper addressing the use of PLS to fuel U.S. Army divisions. This study analyzes PLS in comparison with L-series TO&Es petroleum distribution capabilities and with L-series TO&Es improved to meet the petroleum distribution shortfall. This shortfall centers on,

> . . . a deficiency in the current 5000 gallon tanker to provide enough lift capability for line haul operations of POL. . . . the need for a more responsive Fuel System Supply Point to support larger fuel consuming units. . . . The AirLand Battle-Future Umbrella Concept and the AirLand Battle-Future Distribution Concept established the need for greater throughput capabilities for POL

> distributing units. In addition, these emerging concepts will require the ability to cache fuel forward on the battlefield. [6]

The focus is on the heavy division while applications within the airborne, air assault, and light divisions are left for the reader to infer.

Based on quantitative analysis the study concluded, " . . . the PLS system is the preferred alternative for transporting bulk fuel within the corps and division."[7] The study's conclusion is based predominately on time savings in displacing fuel. Though I agree that displacement time is important, the authors skewed displacement time. They totaled all the displacement times of each unit (petroleum supply company, transportation medium truck company (petroleum), main support battalion, and forward support battalions.) The authors commented on the synergistic effects of moving all classes of supply using PLS but did not support it with evidence. The authors did show that a time savings is possible with PLS over the current 5,000 gallon semitrailer tanker system.

General Tuttle, commanding general of the Army Materiel Command, wrote a two part article that appeared in the September-October and November-December 1991 issues of the Army Logistician addressing the matter of sustainers distributing supplies to warfighters on the AirLand

Battlefield. He says the distribution system is broken and he offers PLS as one part of the solution to the problem.[8] He proposes PLS to improve petroleum distribution, yet, somewhat puzzling, he later goes on to say that the present doctrinal distribution system works well for bulk items like food, fuel, and ammunition.[9] General Tuttle's solution to the Army's broken distribution system revolves around PLS. He extols the virtues of a PLS distribution system and explains how its use can mend many Army distribution problems. Apparently, his aim is to get all supplies moving on the same chassis so a synergistic effect can be realized. General Tuttle proposes to use PLS to enhance petroleum distribution and explains his proposed application.

This is a key work because the senior logistician in the Army has proposed the system and is in a position to influence others. As the commanding general of the Army Materiel Command, he is directly responsible for developing the combat service support systems sustaining Army forces on the AirLand Battlefield. His opinion is important and his comments are highly regarded by those who can make PLS a reality for more than ammunition distribution.

The article is enlightening and thought provoking. It provides a good starting point for this study and

suggests that there is interest in the system and, perhaps, an independent opinion on the matter. General Tuttle's ideas are worthy of investigation.

V. Interviews and Discussions.

During the research of this thesis I contacted several knowledgable professionals who provided ideas on concepts, trends, and current information. Collectively, these logisticians suggested a need for an objective review of the PLS concept. By definition this view must be void of parochialism and aimed at determining the best way to get fuel to the tactical consumers in the quantities desired. The consensus of the group was that the PLS can enhance our current petroleum distribution capabilities. There are definite advantages to be gained by the heavy division in the offense if they use this system. The most important is increased fuel forward. Professionals I spoke with worked in the following offices or positions:

a. U.S. Army Training and Doctrine Command (TRADOC), Truck Modernization, Fort Monroe, VA.

b. U.S. Army Transportation Center and School, TRADOC System Manager, Fort Eustis, VA.

c. U.S. Army Armor Center and School, Directorate of Combat Developments, Support Division, Fort Knox, KY.

d. U.S. Army Quartermaster Center and School, Advanced Petroleum and Water Division, Fort Lee, VA.

e. U.S. Army Quartermaster Center and School, Department of Combat Developments, Materiel, Fort Lee, VA.

f. U.S. Army Quartermaster Center and School, Petroleum and Water Department, Proponency, Fort Lee, VA.

g. Oshkosh Truck Corporation, Marketing Consultant.

h. Center for Army Lessons Learned, Logistics Analyst, Fort Leavenworth, KS.

VI. SUMMARY.

This chapter provides a snapshot of the current state of the literature on refueling the heavy division using PLS. I covered literature related to history, doctrinal publications, periodicals, unpublished works, and the many discussions I had with professionals on the subject of PLS and fueling the heavy division. The key works are a PLS study conducted by the Army and an article

written by the Army's senior logistician. Both key works advocate using PLS to improve supply distribution.

ENDNOTES

[1]Martin Van Creveld, Supplying War - Logistics from Wallenstein to Patton (Cambridge: Cambridge University Press, 1977), 220-221.

[2]Kenneth Macksey, For Want of a Nail: The Impact on War of Logistics and Communications (London: Brassey's, 1989), 97.

[3]Julian Thompson, The Lifeblood of War: Logistics in Armed Conflict (London: Brassey's, 1991), 308.

[4]Thompson, The Lifeblood of War, 3-6.

[5]US Army, FM 101-10-1/2, Staff Officer's Field Manual - Organizational, Technical, and Logistical Data Planning Factors (Volume 2) (Washington, DC: Department of the Army, 1987), vii.

[6]U.S. Army Transportation School, Palletized Load System Follow-on Analysis (Fort Eustis: U.S. Army Transportation School, 1990), Annex C, page 1.

[7]Palletized Load System Follow-on Analysis (1990), Annex C, page 12.

[8]William G. T. Tuttle, "Sustaining Army Combat Forces," Army Logistician, November-December 1991, 12.

[9]Tuttle, "Sustaining Army Combat Forces," 12.

CHAPTER THREE:

HISTORY AND DOCTRINE

I. Introduction.

The purpose of this chapter is to provide historical reference for previously encountered Army petroleum supply and distribution problems and their solutions. It provides a basic understanding of our current petroleum supply and distribution doctrine. No current study of petroleum on the battlefield is complete without some thoughts and information on the one-fuel-on-the-battlefield concept. Last is an examination of the experiences of the British using a palletized loading system (PLS) type system during Desert Shield/Storm.

II. Historical Perspective of U.S. Army Petroleum Supply and Distribution.

We have all heard about boiling oil poured on enemy soldiers scaling castle walls, but petroleum did not take on significance in land warfare until the emergence of the internal combustion engine. As is normal, it took military leaders a while before they saw the utility of using automobiles, trucks, and airplanes to support warfare. The

U.S. Army used trucks before World War I during General John J. Pershing's campaign to locate and capture the Mexican outlaw, Pancho Villa. This experience was just the beginning of a long and intimate relationship between petroleum and the American soldier.

World War I provokes thoughts of the many innovations used by the belligerents in their attempts to break the deadlock caused by the trenches combined with modern weaponry. Innovations ranged from airplanes, to machine guns, to improved howitzers, to chemical warfare, to the tank. These bright new ideas had one thing in common: they all put more strain on the logistical system. The greater the rate of fire yielded a greater need for ammunition, thus the more transportation needed to bring the ammunition forward. Movement of ammunition and supplies forward were limited to animal (horse and mules), human, and machine modes. Machine and animal were the preferred modes. Both needed fuel and both were cantankerous at times. It was hard for "old soldiers" to give up on their animals. Especially since they could eat the animal if times took a turn for the worse. James A. Huston in his book, The Sinews of War: Army Logistics, 1775-1953, illustrates the Allies' reliance on animals during World War I,

> For all the modern advances, the horse rather than the gasoline engine still dominated the supply

> lines. . . . the greatest single class of supplies shipped by the British to France was hay and oats - 5,439,000 tons as compared to 759,000 tons of gasoline and oil."[1]

Nonetheless, World War I provided a slight glimpse of what could be expected as war and the internal combustion engine became acquainted. Mechanization brought with it the need to distribute fuel to these new workhorses.

During World War I both Allies and Central Powers learned about the need to get fuel to the right place on the battlefield. Though armies were entrenched in the mud of Europe, logisticians quickly deduced that they could not take large, clumsy tanker trucks to the forward areas. They realized that these large fuel vehicles made excellent targets for the enemy. One stray bullet hitting a 500-gallon tank of fuel did a lot of damage. With innovation a matter of principle, someone found a way to get fuel forward: drums and cans. Cans were the favorite due to their relative ease in handling and the rate at which they could be used. There were at least two can designs during World War I. The British had a four-gallon flimsy can and the Germans had a 20-liter can. The British can was good for only one trip forward, if it made it that far. It required special crating and punctured easily during handling. On the other side the Germans created a reusable 20-liter can, which was durable and was not prone to the

leakage the British models experienced. The British adopted the German-style cans after using captured German cans to replenish their stocks. Thus, the jerrican (English slang for German can) became the standard in forward fuel distribution.[2]

Though the tank was invented and first appeared on the battlefield during World War I, professionals did not give it the attention it deserved until World War II. Twenty years of innovations and improvements in the automotive field made possible the lethal tanks of the second world war. The logistical systems that tried to keep them fueled were inevitable. World War II consumed our nations attention and its resources. It was truly the first war of full mechanization. Petroleum was consumed in unprecedented quantities. Associated questions and problems arose at all levels. Strategic level questions centered around several points: mix of petroleum products needed, refineries squeezing more high octane aviation gasoline out of a barrel of crude oil, amount of fuel the industrial base needs versus the amount the military forces' need, and the type of fuel new engines need to burn. Operational and tactical level problems centered on getting enough fuel forward to keep thirsty combat units fueled and rolling.

When the Supreme Allied Commander, General Dwight D. Eisenhower decided when and how to invade Europe, he did so after considering all of his options. Surely he knew the logistical effort would be tremendous. Luckily, the logisticians found a way to keep the armies roiling most of the time. The fuel problems encountered by the First and Third (U.S.) Armies as they pushed their way across Europe during the summer of 1944 are legendary. In particular, the Third Army, commanded by General George S. Patton, Jr., and its story of fuel shortages is familiar to most Americans. The efforts and accomplishments of the improvised Red Ball Express serve as a prime example of how the U.S. Army moved fuel to the front. Improvisation, a sustainment imperative of AirLand Battle, proved indispensable in getting fuel to the right place, on time throughout World War II.

The land based forces in the Pacific Theater of Operations (PTO) were mostly amphibious, infantry, and aviation units. Of course, the large consumers of fuel were the aviation units. Retail issues to airplanes in undeveloped areas were by way of muscle. Crews hand-pumped fuel from drums into what surely must have seemed to be bottomless fuel pods.[3]

The significant logistical problems in the PTO were centered on space and time at the strategic/operational level. Space relates to the distance between the islands where fighting occurred, and time relates to the waiting between resupply ship deliveries.

Again, as in World War I, the petroleum workhorse of World War II was the five-gallon can. It was so critical that at times distribution of fuel was held up due to a shortage of them. Time consuming and labor intensive can filling operations and retrieval efforts dominated the petroleum soldier's life. The five-gallon can had proved its worth through another war.

While a case can be made that the Korean War caught the U.S. military and the rest of the world sound asleep, the U.S. petroleum family was merely napping. At the outbreak of hostilities diesel fuel, gasoline, and bunker fuel stocks were at maximum levels though aviation gasoline and jet fuel stocks were not as well off.[4]

Tactical refueling in Korea was accomplished using 55-gallon drums and five-gallon cans. Drums were filled at the petroleum terminal in Pusan and at times in Japan or the United States. Reduction of drums to five-gallon cans occurred as near the point of distribution as possible.

Drums and cans were transported forward on any truck, railcar, or airplane available.[5] Airlift was used extensively to move fuel where the need existed.

> Hundreds of thousands of drums of gasoline and other POL products were air-dropped to isolated units during the evacuation of North Korea, and to supply units advancing in forward areas beyond existing operational airfields and railroad terminals."[6]

Refuel on the move (ROM) is a recently coined phrase for a not so recent idea to refuel vehicles quickly and efficiently during convoys. (An explanation of ROM is provided later in this chapter.) During the Korean War, soldiers of the 425th Traffic Regulating Group set up a refueling operation for vehicles passing through their regulating points. The system they explain appears similar to our modern day ROM. In March 1951 the 425th Traffic Regulating Group set up regulating points with refueling points to handle the 187th Airborne Regimental Combat Team as they convoyed north. CPT Douglas O. Kennedy of the group explains,

> To handle the refueling, we placed signs to indicate the interval between trucks when they halted. Five-gallon cans were stored at intervals alongside the road and an entire serial of fifteen trucks could be refueled at once. Each serial was under way within five minutes. In thirteen hours five hundred trucks were refueled."[7]

Petroleum distribution during the Korean War was not easy. Drums and cans provided hours of backbreaking work

spent loading and unloading trucks, railcars, and airplanes. Also, rolling and falling drums and cans increased the chance of personal injury. Railcars delivered fuel as far forward as possible. Normal operations at the rail destination were for the handlers to transfer cans and drums to trucks while others delivered to customer units. Poor roads and mountainous terrain made truck movements dangerous and difficult and yielded isolated units. Thousands of gallons of petroleum products were air-dropped to these isolated units in the vast expanse of Korea.

The Vietnam War brought with it a new set of problems. Guerilla warfare, tropical weather, and jungle terrain combined to make this an atypical war from the logistical perspective. The idea of base camps surrounded by unsecured land was not normal for Americans. Normally, the U.S. Army likes to have part of its perimeter bordering with friendly elements, mutually supporting friendly fires, and secure supply routes. These elements were not usually available in Vietnam. To remedy the problem of unsecure supply routes the Army used helicopters (or choppers as the soldiers called them) to ferry supplies to the point of need.

While the petroleum workhorse of World War I, World War II, and the Korean War was the jerrican, the petroleum workhorse of the Vietnam War was the 500-gallon collapsible drum. The 500-gallon collapsible drum was called a "blivet" by many grateful soldiers. (Most soldiers today probably do not realize the origin of this nickname. A common theory is that the word blivet refers to the sound a full 500-gallon collapsible drum makes as it hits the ground after being dropped from a helicopter.) The blivet was versatile and met the demands in the Vietnam environment very well. Blivets could be transported by helicopters (sling-loaded externally from Hueys and Chinooks or loaded internally in Chinooks), Air Force intra-theater airlift, tactical trucks, and tactical trailers.

Operation Desert Storm was the first real test for full-scale AirLand Battle Doctrine and its complimentary combat service support doctrine. Sustaining high speed desert warfare proved to be a challenge. The Army's 5,000 gallon semitrailer tankers proved less tactical than some may have thought. What many knew for years finally became undeniable truth: 5,000 gallon semitrailer tankers with any prime mover cannot keep up with M1 tanks and M2 infantry fighting vehicles. This is especially true when tanks and infantry fighting vehicles are moving full speed

across rugged terrain. Heavy expanded mobility tactical truck (HEMTT) with their 2,500 gallon tanks routinely augmented the less mobile 5,000 gallon semitrailer tankers.[8]

Distribution shortfalls were highlighted in after action/lessons learned reports submitted by heavy divisions. The shortfalls were lack of hauling capacity and the poor mobility of the 5,000 gallon semitrailer tankers. Realizing the need for additional hauling capacity the heavy divisions took steps to insure they had enough. An example is the 3rd Armored Division that increased its hauling capacity by accumulating 156 5,000 gallon semitrailer tankers before it crossed the line of departure.[9] This is a significant increase over the 64 authorized in the heavy division's support battalions. The 1st Infantry Division (Mechanized) commented in their lessons learned about the capacity shortage,

> Unit fuel haul capability was supplemented by additional tankers, but units still had to halt to wait for fuel to be brought forward. The basic problem is that current TO&Es support peace-time operations, but are totally inadequate for a fast moving offensive operation that supports current doctrine. Unit TO&Es should be adjusted to reflect cargo and fuel hauling requirements for offensive operations.[10]

With regard to mobility, the 3rd Armored Division commented in their after action report that,

> . . . in armored warfare, especially in third world countries, mobility is a major issue. The lack of mobility of . . . 5000 gallon tankers

> severely hampered 3AD operations. The HEMTT family of vehicles, on the other hand, moved with ease throughout the battlefield and quickly became the true workhorse in support of logistics operations. Recommend the HEMTT family of vehicles become the prime movers of fuel and ammunition in the heavy division.[11]

The 1st Infantry Division (Mechanized) echoed these sentiments, "5,000 gallon tankers could not move effectively until MSRs were created . . . The mobility of corps and division vehicles must be geared to cross country movement, not highway movement."[12]

As illustrated above, Desert Storm proves that the fuel distribution system in the heavy division is less than adequate. Luckily, improvisation overcame a lack of anticipation.

III. Current U.S. Army Petroleum Distribution Doctrine.

To understand the impact PLS can have on fueling the heavy division one must understand the current petroleum distribution system. Also, understanding the current system is critical for improving effectiveness. Therefore, in this section I present the current U.S. Army petroleum supply and distribution system. Focus is on the tactical level. This overview starts at the point of government receipt and ends with the issue to the ultimate consumer in the field.

The Defense Logistics Agency (DLA) is the single item manager for bulk petroleum with responsibility for obtaining and providing fuel from the strategic level down to the operational level for all Department of Defense agencies and other organizations as directed. DLA accomplishes this mission through one of their subordinate commands: Defense Fuel Supply Center (DFSC).

Once DFSC obtains unified command and service requirements, DFSC makes arrangements to deliver the fuel where the customer desires. DFSC makes wholesale fuel deliveries as far forward as possible. Usually, the deliveries are made at a seaport, river port, refinery, commercial storage depot, government storage depot, or along a pipeline transfer point. The fuel passed to the service meets established use standards and is ready for issue to the ultimate consumer.

As the responsible agent for inland petroleum distribution, the Army accepts the fuel from DFSC and eventually moves it to all customer units.[13] These customer units usually include U.S. Air Force bases, U.S. Army units, U.S. Marine units, as well as, authorized foreign units.

Within a developed wartime theater of operations, several players interact at the theater level to plan, control, manage, and issue bulk fuels. The joint petroleum office (JPO) works on the unified command staff. They accumulate long term (1 month or more) service requirements and then provide these theater fuel requirements to DFSC. The theater army commander (component commander) has an energy officer (or section) overseeing petroleum matters for Army units and promulgating theater army petroleum policies. The theater army materiel management center (TAMMC) has a petroleum directorate overseeing the management of theater level stocks and serves as the item manager for all bulk fuel in the theater. The directorate also plans for future operations and provides materiel management direction to the theater's petroleum group. The TAMMC petroleum directorate works closely with the theater army commander's energy officer on policy matters and the JPO on operational matters.[14]

The theater level petroleum operator is the petroleum group. The group's mission is to coordinate the operation of the theater level distribution system, primarily interzonal pipelines. This includes its primary responsibilities of receiving fuel from DFSC and moving it to customers as directed by the TAMMC. The petroleum group is task organized with the appropriate number of petroleum

terminal and operating battalions and any additional units to meet its mission.[15]

The petroleum group's primary Army customers are theater army area commands (TAACOMs), corps, and independent divisions. Once the group receives the customers' requirements, the group starts the distribution process in motion. The group provides direction to its subordinate operating battalions so they can move bulk fuel to the area of need. Along with customers' requests for fuel is information on the desired method of delivery and any special requirements. Requests for a certain mode of transportation is weighed heavily when deciding the mode to be used to meet the need. All things being equal the preferred mode of transportation is the one that gets the fuel to the customer with the least amount of handling and transloading and meets the customer's off-loading restrictions.

The basic concept at theater level is to deliver fuel in the largest practical container for the receiver. Emphasis is on transloading as far forward as possible. Throughput, or by-passing of one or more intermediate distribution points, is used if assets are available and the customer can accept the equipment and quantities the group sends forward. Normally, the corps' petroleum supply

battalions are the major customers of the petroleum group with the petroleum supply battalion making further distribution forward.

The petroleum supply battalion, a subordinate unit of the corps support command (COSCOM), is task organized to distribute bulk fuel to the corps and other units as assigned. A petroleum supply battalion normally has a combination of the following units assigned to meet mission requirements:

1) petroleum supply company (normally one per division slice).

2) transportation medium truck company (petroleum) (normally habitually related with one petroleum supply company).

3) petroleum laboratory (augmentation as required).

4) headquarters and headquarters detachment.

5) pipeline and terminal operating company (may be assigned if corps is largest Army force in theater).[18]

The petroleum supply battalion uses various modes of transportation to move fuel to its customers. The focus here is on delivering fuel as far forward as possible. If the petroleum supply battalion can deliver directly to the final DS customer then the best situation occurs. At this level throughput to the divisional forward support battalions (FSBs) is more of a reality than it was at the petroleum group. The petroleum supply battalion can by-pass a divisional main support battalion (MSB) and deliver straight to an FSB if the situation and resources permit. In most applications the petroleum supply battalion delivers the fuel to the MSB, who in turn delivers the fuel to the FSBs. Doctrinally, the petroleum supply battalion is responsible for moving aviation fuel to the divisional aviation brigades. This reduces the need to double handle the fuel at the MSB. In addition, the petroleum supply battalion is normally thought of as a general support (GS) unit, yet it is assigned the additional mission of providing direct support (DS) to units in its locale.[17]

In the heavy division, the principal recipients of bulk fuel from the corps are the MSB, three FSBs, and the combat aviation brigade. These are the DS suppliers of the division. Their bulk fuel responsibilities center on making bulk fuel available to the maneuver battalions and

their combat support elements. Normally, ground fuel is delivered to the MSB's bulk class III supply point. Here fuel is transferred to collapsible storage bags or 5,000 gallon semitrailer tankers for further distribution to the FSBs. Whenever possible, the division materiel management center requests direct delivery directly to the FSBs. Throughput to the FSBs is preferred to reduce resources spent on transfer operations at the MSB or the combat aviation brigade.[18]

In fast paced offensive operations there is a need to build up fuel stocks in forward areas. There are at least two ways to accomplish this: place collapsible storage bags on the ground or pre-position 5,000 gallon semitrailer tankers. Using the latter provides the most flexibility, responsiveness, and eases relocation.

The lack of collapsible storage bags in the FSB requires fuel to be delivered via some type of tanker transfer operation. This situation allows the commander of the division support command to weight the heavy division's main effort by attaching additional 5,000 gallon semi-trailer tankers to the FSB supporting it. Shifting equipment allows the commander to efficiently use the division's resources to more effectively support offensive operations. This rolling storage concept increases the

FSB's mobility and increases stocks held forward. Increased mobility allows the FSB more ability to fuel the maneuver brigade but only over improved roads. Increasing stocks held forward shortens the amount of time HEMTT tankers spend going to pickup fuel for the maneuver battalions. This idea adds nothing to the FSB's cross country fuel hauling capability.

The tanker transfer may be a direct exchange of a full 5,000 gallon semitrailer tanker for an empty 5,000 gallon semitrailer tanker. It can also consist of pumping fuel from the full semitrailer tanker to the empty one. Another option is for the full semitrailer tanker to deliver to waiting HEMTT tankers belonging to maneuver battalions. Once fuel is delivered to the FSB, the tactical situation will dictate whether fuel gets delivered to customer units or the customer units return to the supply point for their fuel. Doctrinally, bulk class III distribution within the maneuver brigade area of operations is by supply point distribution.[19]

One concept used by heavy divisions during offensive operation is refuel on the move (ROM). ROM is best employed during the preparation phase of the offense but it may also be employed during exploitation or pursuit when relative security is possible at the ROM site. ROM is

essentially a mobile filling station with multiple fueling points used to refill convoys of tactical vehicles. A ROM includes retail fuel dispensing equipment connected to some type of bulk fuel storage. It is most effective when used in a secure location adjacent to a convoy route. Using this method, commanders and logisticians ensure vehicles are topped off before deploying into battle or getting back into the fight.[20]

A prominent strength of the current fuel distribution system is that it is well established. The system is simple, yet flexible. It allows planners and operators to make adjustments to meet maneuver units' needs. Centralized control is the key ingredient in the success of the fuel distribution system. The centralized control includes controlling the stocks of fuel and the transportation assets moving the fuel to the GS and DS supply points.

The versatility of our petroleum distribution system manifests itself in the ease in which ROM was adopted. The ROM concept codifies an idea that saw success in the Korean War. This codification, and acceptance as doctrine, allowed combat developers the opportunity to develop ROM equipment packages. These packages ease the supply

sergeants job of obtaining the extra petroleum equipment needed to establish ROM kits.

The HEMTT tanker has possibly done more for petroleum distribution than any other piece of equipment since the 500-gallon collapsible drum (blivet). This tanker truck has the mobility, reliability, and hauling capacity needed to meet the demands of the modern battlefield. The HEMTT tanker takes off where the 5,000 gallon semitrailer tanker stops.

Weaknesses of the current system revolve around the limited off-road mobility of the 5,000 gallon semitrailer tankers. They are substantially less mobile over rough terrain than HEMTT tankers and the tactical vehicles they support. Though it may have cross country tires it cannot stand up to the rigors of fast movement over rough terrain. The 5,000 gallon semitrailer tankers were designed to provide support over improved roads not rough terrain.

Collapsible storage bags are a good temporary system for storing fuel in static situations. They are not a good source of storage space for a division conducting fast paced offensive operations. Also, they are not a good idea for storage when the division is in a mobile defensive situation that may require them to retrograde quickly.

Collapsible storage bags are bulky and cumbersome to install and retrieve. In addition, these tasks are resource intensive.

IV. Impact of One-Fuel-On-The-Battlefield.

On 11 March 1988 the Deputy Secretary of Defense, William H. Taft, IV, signed Department of Defense Directive 4140.43, subject: Fuel Standardization, and set the one-fuel-on-the-battlefield concept in motion. The directive specifically dictates that, "Primary fuel support for land-based air and ground forces in overseas theaters shall be accomplished using a single kerosene-type fuel, designated JP8, when approved by the Unified Commander."[21] This means the Army will use a kerosene-type fuel (JP8) to meet all of its fuel requirements. This translates into the soldier using the same fuel in his generator and vehicle as the aviator uses in his aircraft. The directive goes on further to address the use of gasoline,

> The DOD components shall strive to eliminate the need to stock, store, and issue bulk motor gasoline in foreign countries by the year 2010. This may be done by replacing equipment using gasoline with equipment using either kerosene or distillate-type fuels.[22]

This one-fuel-on-the-battlefield concept will eliminate the need to decide which type of product to place in storage vessels. No longer will there be a need to make

a winter blend of diesel fuel when the temperature drops. All fuel transported, stored, and consumed will meet the same quality specifications. The new fuel of choice (JP8) is safer than motor gasoline and the current jet fuel (JP4) used by Army units in the Continental United States. Though JP8 eliminates the diesel fuel cold weather problem, it does not produce smoke like diesel fuel does when poured on a hot, tank engine manifold.

Because of the move to one fuel for the entire force, the heavy division can simplify its petroleum distribution system. For example, one ROM site will have the potential to refuel vehicles, stationary equipment, and helicopters from the same source. The task of switching products in a 5,000 gallon semitrailer tanker and the problem of commingling fuel in them will no longer exist. Combat aviation brigades will be able to go to the MSB or FSBs for fuel resupply. The problems associated with having enough space to accept a load of motor gasoline will be eliminated. The problem of someone pouring gasoline into a diesel driven generator will be history. One-fuel-on-the-battlefield eliminates these annoying problems. A problem one-fuel-on-the-battlefield does not solve or reduce is the heavy division's horrendous appetite for fuel. But, it does reduce some of the problems division

class III officers face when supporting the division during offensive operations.

V. British Experience During Desert Shield/Storm.

A. Overview.

The British contingent to support the coalition efforts (Operation Granby) in Desert Shield/Storm included 1 (U.K.) Armour Division and a host of nondivisional support elements. These elements included Royal Corps of Transport (RCT) units responsible for moving all the supplies needed by British forces. The demountable rack off-loading and pickup system (DROPS), a forerunner of the U.S. Army's PLS, was not delivered to the first British transportation units until shortly before the forces movement to the Kuwaiti Theater of Operations. By 20 October 1990, the first British transportation units started receiving DROPS in Al Jubail, Saudi Arabia. The DROPS were used extensively to move water, fuel, ammunition, and trash.[23] The British employed DROPS primarily at their third line which is analogous to our GS level. The responses reviewed prove DROPS to be a boost to the British Army's distribution system. It appears as if DROPS improved efficiency in every application.

B. Strengths.

A significant strength of DROPS is its engineering and craftsmanship. When a vehicle is designed to meet the rugged demands of an army and is then built with attention to detail, the results are soldiers and leaders confident in their equipment and their ability to accomplish the mission. These qualities are alluded to by an officer in the 8 Regiment RCT, "DROPS was a definite logistic success story. The robustness of the vehicle, the few mechanical problems, which were solved by the drivers and fitters, and the flexibility of the system were very impressive."[24]

The versatility of DROPS comes shining through every report on its use in the desert. The system was used for several different types of supplies. From ammunition, rubbish, and other dry cargo to wet cargo including water and fuel. A senior officer's comments illustrates the versatility and usefulness of DROPS,

> We also employed DROPS to move fuel 'Bean Cans'similar to the water ones, mainly to sites requiring a static tank facility. . . . DROPS was significant and is clearly the system for the future and it has great potential for wider applications. The doubters must now be silent, if there are any left. If any remain, they did not serve in this theater."[25]

The true worth of DROPS came to light as the port facilities were inundated with incoming materiel. Here the

Adjutant, 8 Regiment RCT explains DROPS value at the port,

> It was at this stage that the advantages of the DROPS system really shone through. A huge move of all ammunition and stores took place, as the Division came under command of 7 US Corps. 10 Regiment RCT set up "the loop" - a harrowing 30 hour round trip that the drivers completed dozens of times. The main task being to move MLRS ammunition. The flexibility of DROPS meant that only one or two vehicles were required to offload a ship and line up the loaded flatracks ready for the convoy of vehicles on arrival at the port to each pull on a flatrack and drive away.[26]

During the Desert Storm ground war the 1 (U.K.) Armour Division moved at the same fast pace as their higher headquarters, VII (U.S.) Corps. The 1 (U.K.) Armour Division was constantly jumping its concept service support units during the drive the operation. The following excerpt gives one person's view of the movement and how DROPS contributed to success,

> The speed of the advance of the Division was such that the admin area moved three times in as many days. Once again the slickness of the DROPS system paid dividends in the rapid resupply of water bean-cans and MLRS rocket flatracks. The further the Division moved, the greater the number of DROPS vehicles that had to be used to deliver water. When the Division finally halted well inside Kuwait, all available DROPS were being utilized to provide water for the force. . .[27]

True acceptance of a system, such as DROPS, can only be measured by how quickly the officers and senior noncommissioned officers put the system to work and incorporate it into critical plans. With DROPS we see a system that was put to work immediately upon introduction into the theater of operations. The systems was so

successful that units scrambled to find more of the racks they wanted to use and they kept the systems busy. The ultimate compliment was paid to DROPS by a British senior officer, "Particularly impressive was the performance of DROPS. . . . Wide experience had been gained in the use of DROPS and the concept was fully integrated into the logistic re-supply system."[28]

C. Weaknesses.

Finding weaknesses in DROPS from the articles and information surrounding British involvement in Desert Shield/Storm is a difficult task. To find any weakness one must read between the lines. Weaknesses I derived were late initial delivery of the system and the different types of racks available for use. The late initial deliveries of the DROPS slowed their full integration into the support system. Though some drivers received some training in Europe before they were shipped, it is certain that most of the drivers learned to drive DROPS in Saudi Arabia. The different type of racks made it difficult at times to locate the proper rack for a task. ISO compatible racks were the sought after type for dry cargo.[29]

VI. Summary.

This chapter provided an historical reference for the previously encountered Army petroleum supply and distribution problems and their solutions. The current petroleum supply and distribution doctrine was provided to lay a foundation for the following chapters. Information on the one-fuel-on-the-battlefield concept was provided and its impact on fuel operations in the division was explained. Last, the experiences of the British using a PLS type system during Desert Shield/Storm were provided to serve as a reference for a modern example of how a PLS type system can benefit a heavy division.

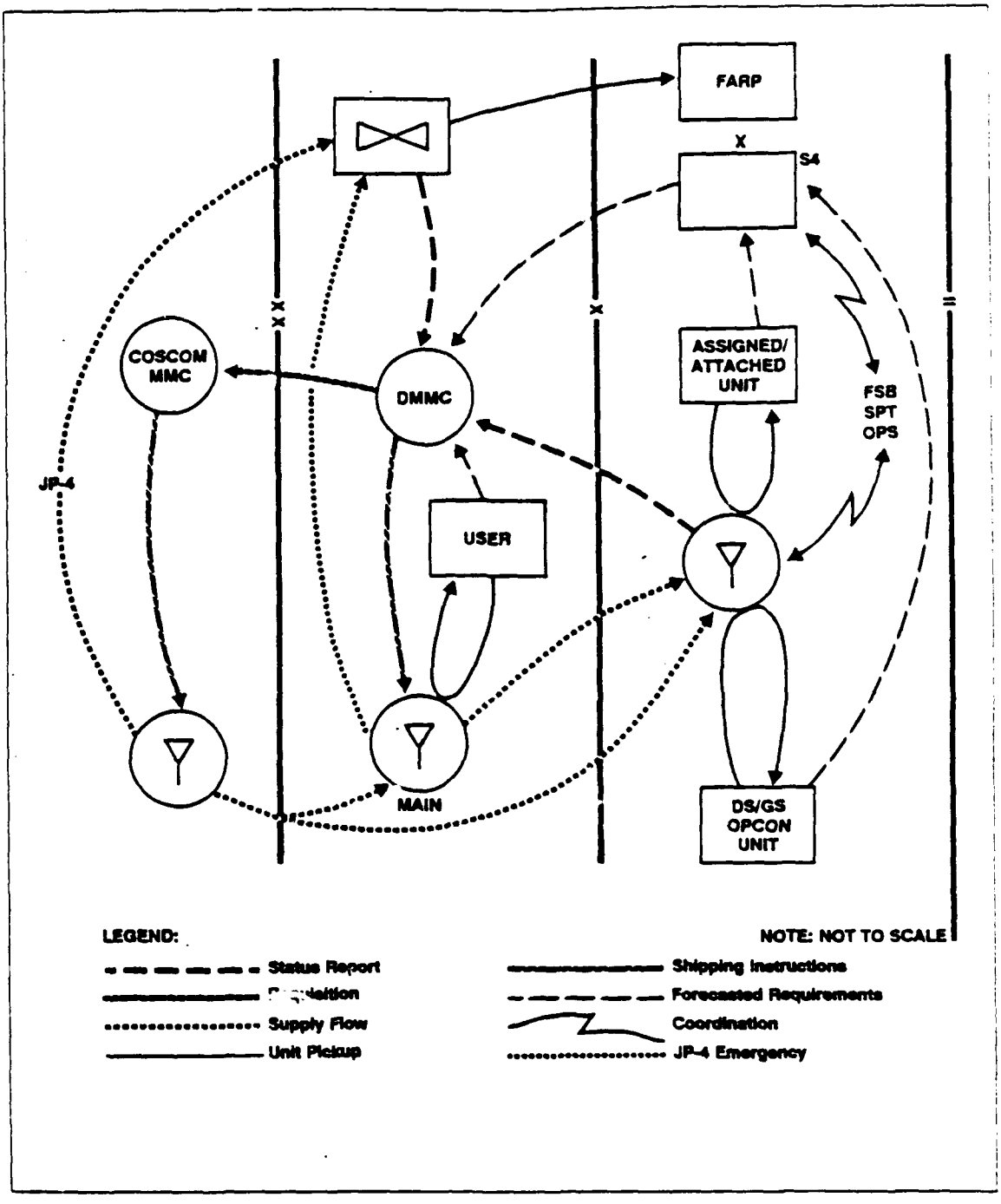

Figure 2-1
Bulk Fuel Supply
Main Support Battalion, Heavy Division Perspective
(Source: FM 63-21, Main Support Battalion, page 5-12)

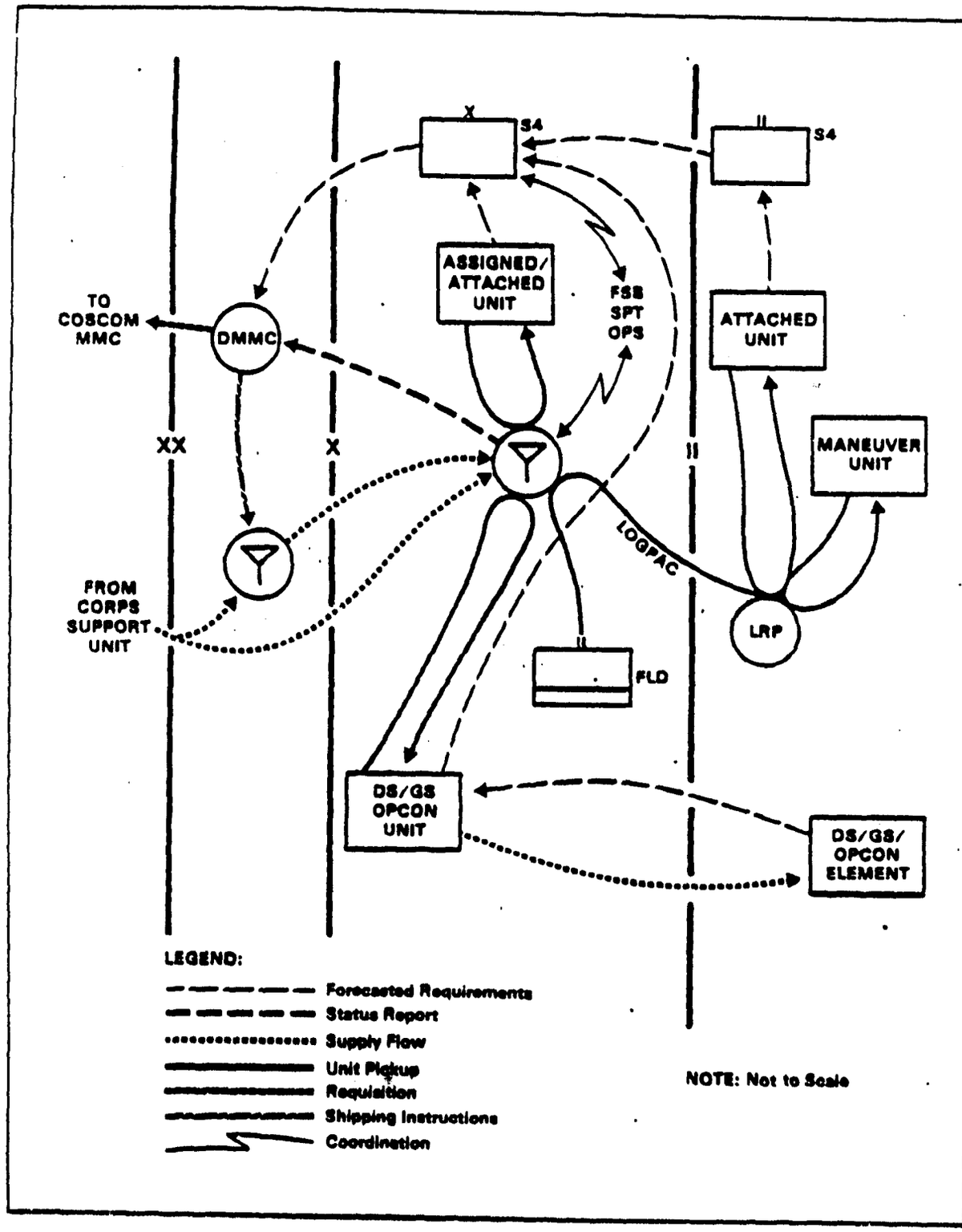

Figure 2-2
Bulk Fuel Supply
Forward Support Battalion, Heavy Division Perspective
(Source: FM 63-20, Forward Support Battalion, page 7-14)

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CHAPTER FOUR:

PROPOSED PETROLEUM PLS DISTRIBUTION SYSTEM

I. Introduction.

This chapter explains my proposed bulk petroleum distribution system using PLS with bulk petroleum hauling capacity as its focal point. Covered first is my idea of how PLS should be employed to fuel the heavy division. Then I cover the equipment characteristics needed to make PLS tankracks usable. When you complete this chapter you will have a basic understanding of the equipment and how I propose employing it to distribute bulk fuel on the AirLand Battlefield.

II. Proposal.

A. Concept.

The heavy division contains sixty-four 5,000 gallon semitrailer tankers. This equates to 320,000 gallons in somewhat mobile fuel stocks. I say somewhat mobile because there are only fifty-five tractors dedicated to moving them. This equates to only 86% or only 275,000 gallons being

movable by the division in one lift. The remaining 14% or 45,000 gallons will not be moved until nine of the tractors return to move them to the point of need. All of this 320,000 gallons is on wheels but it is on 5,000 gallon semitrailer tankers that are far from being fully mobile in all the places a division must go to execute its mission. The added burden of returning to pick-up the remaining 45,000 gallons is not a quick process. I propose replacing the sixty-four 5,000 gallon semitrailer tankers with sixty-four PLS tanker/trailer systems. With these PLS systems are one hundred and twenty-eight tankracks holding 3,500 gallons each. This exchange provides 448,000 gallons of mobile fuel stocks. This is an immediate increase of 173,000 gallons of truly mobile fuel stocks.

To support and complement the PLS tanker/trailer systems in the heavy division, the corps operates with PLS tanker/trailer systems. The sixty 5,000 gallon semitrailer tankers in each transportation medium truck company (petroleum) are replaced with sixty PLS tanker/trailer systems and the associated 120 tankracks. This increases the maximum one time lift of the unit 120,000 gallons from 300,000 gallons to 420,000 gallons. Additional PLS tankracks are assigned to the petroleum supply company and are pushed forward to back-up the main support battalion (MSB). This may preclude MSBs from the task of placing

10,000 gallon collapsible fuel storage bags on the ground and the eventual task of retrieving them for movement. PLS tankracks can be further missioned to supplement the forward supply battalions' (FSBs') and the combat aviation brigade's one day of direct support (DS) stockage.

Heavy expanded mobility tactical truck (HEMTT) tankers stay in the maneuver battalions and the combat aviation brigade within the heavy division. The HEMTT tankers' proven ruggedness, maneuverability, and combat effectiveness will serve combat soldiers well for years to come. Another positive point for keeping the HEMTTs around after PLS arrives on the scene is their 45% plus parts interchangeability with the PLS trucks currently in production for the U.S. Army.[1]

Fuel requirements flow through the system in essentially the same manner they do currently. In addition, the S-4s must include in their fuel forecasts the location of empty tankracks. Also, they must provide the time of availability and location of other tankracks under their control. Asset visibility over empty tankracks for backhaul is a concern. The importance of the S-4s passing timely and accurate information on empty tankracks cannot be over emphasized.

The corps transportation medium truck company (petroleum) delivers the required tankracks to specified locations. These same corps assets backhaul empties to the next tankrack transfer location. The petroleum supply companies serve as the hubs of the system. All corps empty tankracks circulate through the companies' refuel points for filling and serviceability checks. Drivers exchange empties for full tankracks. During initial deployments, initial employments, and other special situations there will be some deliveries when empty tankracks are not available for backhaul. In these situations, the PLS truck may carry non-petroleum racks provided the delay in their estimated arrival time at their next pick-up meets the approval of their parent unit. This situation requires intense management to eliminate the misuse of these valuable assets.

Conceptually, this idea allows MSBs and FSBs to have fuel delivered as far forward as the combat trains of the maneuver battalions in the main battle area. It is also possible to deliver fuel to the units engaged in deep maneuver and other deep operations. It allows fuel to be delivered with no division manpower involved at the delivery site. Delivery sites can be almost anywhere the division has a need though the preferred site is somewhat level, well drained, and lends itself to cover and concealment. Once the delivery point is established, the driver picks up his

load of fuel and proceeds to the site. Upon arriving at the location he verifies and records his exact location. He then reviews his orders for special placement instructions and proceeds to drop his tankrack(s) in the best camouflaged, yet accessible position. This all can take place without a person from the supported unit being on-site.

The division can place tankracks to serve as fuel oases for thirsty tank, mechanized, or aviation units. These locations can be within or outside the main battle area. Anywhere the division sees a current or anticipated need for fuel and the risk is worth the benefit then the division can establish a tankrack cache or oasis of fuel. This dispersion of class III points will shorten the time maneuver battalion HEMTT tankers spend going to the rear to replenish their tanks. Therefore, HEMTT tankers have more resources (time and fuel) to spend in servicing the maneuver battalions during the fast paced offense.

Lone HEMTT tanker operators transferring fuel from tankracks to HEMTT tankers will find the task quick and easy. This quick and easy transfer with only one operator will ensure proper support for secondary missions while weighting the main effort with the bulk of available support. An example is the support the cavalry squadron needs while conducting covering force operations. While the

cavalry squadron is performing its mission the remainder of the division is preparing for the main battle. With limited support personnel, the cavalry squadron can receive the fuel needed for success.

Responsibility for success of the one man delivery lies with both the supported and the supporter. The supported customer must identify PLS tankrack drop sites that are accessible by the PLS truck, somewhat level and drained. The customer must consider whether he desires to meet the PLS driver and escort him to the drop site or conduct a one man delivery. If a one man delivery is chosen then the customer must communicate exactly what he wants via the bulk fuel request/forecast. Instructions related to the desired placement of the tankrack must be spelled out in plain, simple language. As a minimum a map reconnaissance is required though an on-site reconnaissance is preferred. Despite the type of delivery required, an estimate of the security level of the drop site and the possible route must be included. This information could prove to be the difference between fuel and no fuel. In areas where interdiction is probable, the customer must provide security for the PLS system once it enters the customer's area of operations.

The supporters' responsibilities are critical to the success of this concept, also. Their first and foremost responsibility is to ensure the requirements stated in the bulk fuel request/forecast are clear, understood, and specific enough. If there is any doubt then the supporter must contact the customer for clarification and details. The driver of the PLS must identify the exact location of the tankrack(s) using either a map or global positioning system. Also, the driver must identify obvious terrain and security problems associated with the location. Once obtained, the driver passes it, with information on the quantity and other pertinent information, to the customer and his truckmaster.

The concept also reduces handling and movement costs (man-hours and transportation assets) associated with moving the fuel from the brigade or division support areas into different locations. An immediate 50% reduction in man-hours expended on deliveries using the one man delivery method is obvious. The more deliveries are made closer to the eventual customer then the less transfer handling is required. This includes the transfer of like 5,000 gallon semitrailer tankers and unlike 5,000 gallon semitrailer tankers, transfer of fuel from corps 5,000 gallon semi-trailer tankers to divisional 10,000 gallon collapsible bags and then into divisional 5,000 gallon semitrailer tankers,

and the transfer of fuel from 5,000 gallon semitrailer tankers to HEMTT tankers. This concept helps increase throughput by not only carrying 2,000 gallons more than the 5,000 gallon semitrailer tankers but by traversing terrain the 5,000 gallon semitrailer tanker cannot. The PLS system can get fuel farther forward in difficult terrain and once on-site the fuel can be issued into using vehicles.

This system gives the division additional capability to disperse fuel stocks throughout the battlefield. Increasing the number of supply routes and supply points reduces the signature of the brigade and division support areas. Caches can be established anywhere the division deems fit and is willing to risk the movement to the area and the placement of the stocks in the chosen locations. I emphasize that this decision is more than a decision to be made by the division logisticians. The operations officer must be aware of this option and must coordinate the placement of these supply points. Of course, this all hinges on the tactical commander making the decision to establish caches.

A communications process must be in place to let the division units know positively the delivery location and quantity of their requested fuel. Mission completion reports must include remarks to indicate possible enemy

activity and other significant information. This cannot be left to management by exception. Fuel is too important a commodity to risk enemy interdiction of deliveries. The added problem of a delivery to an unmanned point increases the need to communicate, "mission accomplished!"

A concern of commanders, combat leaders, vehicle operators, and mechanics is the quality of fuel going into their equipment. Currently the quality of fuel in the heavy division is not a critical concern. After loading and testing the fuel, determining the tank vehicle is clean, and the driver beginning his journey to the delivery point/ customer, the fuel stays with the driver until transferred to another person. The fuel never gets out of the sight of friendly forces. If the tankracks are employed to their full potential, then there will often be times that the tankrack, with its load of fuel, is not under friendly surveillance. Therefore, it is important that once friendly forces locate the tankrack and prepare for refueling operations that they have a way of deciding that the fuel is fit for use.

My proposal to avoid this dilemma follows. The petroleum supply company's organic laboratory tests the fuel and seals the tank rack after certifying the fuel meets use specifications. At the battlefield supply point the intact

seal will serve as the refueler's assurance of quality. The type of seal used will show any attempts of tampering. Many seals meeting this requirement and easy to remove without special tools are available commercially.

Control of petroleum transportation assets at the division level remains the division materiel management center's class III section's responsibility. No divisional PLS tanker systems move, off-load, or pickup fuel without their approval. Control of general support (GS) petroleum transportation assets at the corps remain under control of the corps materiel management center's class III section and the petroleum supply battalion. Though this proposal increases capability, assets are still critical and must be centrally controlled. Movements must continue to be coordinated between concerned movement control teams and highway regulating point teams for use of main supply routes and supply routes.

B. Physical Characteristics.

To meet the needs of the concept just explained, the PLS tankracks must have certain characteristics. The PLS tankracks must have an onboard pump, filter/separator, simple to read gauges, and simple operating instructions. To be versatile, interoperable, and manageable, connections

must include those for 5,000 gallon semitrailer tankers, HEMTT tankers, and aircraft. A retail servicing nozzle for ground vehicles is another significant piece of equipment to be included. Aircraft refueling nozzles (closed circuit refueling (CCR) and center point (D-1)) would be distributed to the combat aviation brigade, MSB, and FSBs as required.

Without these minimum characteristics the PLS tankracks will not be able to meet their mission. The tankracks must be equipped to meet the demands placed on them by the maneuverability of the PLS. Once a proven bulk fuel hauler that can meet the cross-country needs of the heavy division, the PLS will be called upon to interface with all fueling equipment on the battlefield. Planning and engineering now to meet this need reduces the need for quick, impromptu fixes later.

III. Summary.

The main thrust of this idea is to replace existing 5,000 gallon semitrailer tankers within the corps (divisional and non-divisional units) with 7,000 gallon PLS tankrack systems. Planning and executing one man deliveries of tankracks will take practice and coordination. Trust in the system and the people behind it will be critical to getting empties identified and returned.

The tankracks delivering fuel to the heavy division and those used by the heavy division must be versatile and interface with the equipment found in the division. Planners and engineers must realize the need to see into the future. They must anticipate the equipment changes the heavy divisions will most likely want and plan accordingly.

The concept explained in this chapter is just one opinion on how the PLS can be used to meet the needs of the heavy division.

ENDNOTE

[1]Walt Garlow, Marketing Consultant, Oshkosh Truck Corporation, interview by author, telephonic, 24 February 1992.

CHAPTER FIVE:
ANALYSIS OF PETROLEUM PLS DISTRIBUTION SYSTEM VERSUS CURRENT PETROLEUM DISTRIBUTION SYSTEM.

I. Introduction.

This chapter compares the proposed system with the current system by looking at the differences between the equipment and the application of the equipment. When you complete this chapter you will understand the differences, advantages, and disadvantages of each system when compared to the other.

II. Comparison of Equipment.

A. Bulk Fuel Delivery Time.

The time required to make a bulk fuel delivery, off-load a 5,000 gallon semitrailer tanker, conduct a trailer transfer, or drop a PLS tankrack, may be significant but it is not critical for choosing a bulk fuel semitrailer tanker or replacement. The PLS can drop 7,000 gallons in tankracks and pickup empty tankracks in about 20 minutes. The 5,000 gallon semitrailer tanker can off-load its fuel in about 33 minutes while a 5,000 gallon

semitrailer transfer occurs within 10 minutes. These numbers provide plenty of opportunity for calculating and comparisons but rapid off-loading is not the critical link. More critical to 5,000 gallon semitrailer tanker operations is a storage container or empty trailer to receive the fuel. The time required to place the equipment, pump the product, and then prepare to depart is insignificant when compared to the real problem of finding empty storage space. Similarly, a critical link the PLS is locating empty tankracks to backhaul.

Advocates of PLS boast of the system's ability to pickup or drop a rack in two minutes by one operator.[1] Given this information and estimating the time for other associated tasks, the estimated total time to exchange two full tank racks for two empty tank racks is about 20 minutes.

Here is how the 20 minutes are derived. Initially, when the PLS arrives it takes about three minutes to position and disconnect the trailer then position the PLS. The trailer must be disconnected so the first tankrack can be dropped. Then two minutes are needed to drop a full tankrack. Consuming another three minutes is positioning and connecting the trailer, then repositioning the PLS. Again, two minutes are required to drop a full tank. The

positioning of the truck takes about a minute. Recovering the empties starts with the two minutes needed to place an empty tankrack on the trailer. To position and disconnect the trailer so an empty tankrack can be placed on the PLS truck takes three minutes. Another minute is needed to reposition the truck. Once in position, picking up another empty tankrack requires two minutes. Now, all that remains is the minute needed to position the truck, connect the truck to the trailer, and drive away. Total time from arrival with two full tankracks and departure with two empty tankracks is approximately 20 minutes.

Transferring product between 5,000 gallon semitrailer tankers is not an uncommon occurrence in the heavy division. Using 225 gallons per minute as the tanker discharge pump rate and the rate of transfer between tankers, the time required to transfer fuel safely between 5,000 gallon semitrailer tankers is about 33 minutes.

At this point one may ask, "Why can't the two operators just switch 5,000 gallon semitrailer tankers?" This can be done between tankers within the division but is usually not practicable between transportation medium truck company (petroleum) tankers, other corps level tankers, and divisional tankers. The only time it is practicable is when the two units have the same basic type of semitrailer

tankers. The corps level tankers are fuel-transporting (or bulk) tankers and the divisional tankers are usually fuel-servicing tankers. The difference being the fuel-servicing tanker has an integral filter/separator and thus the ability to issue to using vehicles. The fuel-transporting tankers do not have this ability and as a result are less versatile. They can only be used to issue in bulk to storage containers or other tankers.

The 33 minutes to transload fuel between two 5,000 gallon semitrailer tankers break down into the following tasks and times. When the delivering 5,000 gallon semi-trailer tanker arrives, the operator consumes about six minutes positioning the tanker, putting fire and safety/ environmental equipment in place (i.e., grounding, bonding, and drip pans), connecting hoses, and placing the pump in operation. Actual transfer of the product takes about 22 minutes (transfer of 5,000 gallons of product at 225 gallons per minute). To disconnect hoses and grounds/ bonds, stow equipment, and prepare for movement requires about five minutes. Total time required to transfer 5,000 gallons from one tanker to another is approximately 33 minutes.

The current preferred method of delivering fuel between the general support (GS) level (transportation

medium truck company (petroleum) and main support battalion) and the direct support (DS) level (main support battalion and forward support battalions) in the heavy division is a tanker transfer operation. The GS unit delivers a full 5,000 gallon semitrailer tanker to the DS unit. Then, the DS unit gives an empty one to the GS unit for backhaul and future replenishment.

A trailer transfer operation between two 5,000 gallon tankers of the same type (both must be fuel-servicing or both must be fuel-transporting) takes about eight minutes. Positioning, preparing for free-stand, and disconnecting the tankers requires about five minutes. Positioning, connecting, and preparing for movement consumes approximately three minutes. So, in less than 10 minutes a trailer transfer can be completed safely and effectively.

From this analysis you can see that trailer transfer operations, the currently preferred method, are the most time efficient method of delivering bulk fuel. This savings in time can be helpful but it is dependent on having empty semitrailer tankers at the supply/transfer point.

B. Maneuverability.

The PLS tanker/trailer system includes a PLS truck that has five axles and maneuverability similar to the heavy expanded mobility tactical truck (HEMTT). The Waterways Experiment Station of the Corps of Engineer has conducted mobility comparison testing between the HEMTT and the PLS. The testing included the HEMTT with a payload of 11 tons and the PLS at payloads of 11, 13 and 16.5 tons. In their comparison they concluded that, "At 16.5 tons, the PLS outperforms the HEMTT in many terrain and surface conditions. . . . The superior ride performance of the PLS is a distinct advantage over the HEMTT."[2] The memorandum went further to say that,

> When you consider the load and unload times associated with the two vehicles and the closeness of . . . 32 mobility factors . . . it appears that in most instances the PLS exhibits better performance than the HEMTT.[3]

When the PLS tanker/trailer becomes stuck up to its axles in mud, it has the unusual ability to extricate itself. It frees itself using its racks and hydraulic arm. Once stuck, it removes a rack, places it on the ground behind the truck and then pushes off the rack raising itself up and out of the quagmire.

Helping in this feat of self-recovery are three axle steering and a central tire inflation system. The three

as HEMTTs or other large commercial trucks do with dual front axles. The third steering axle is the trail axle on the vehicle that steers, on command, to help maneuver. The central tire inflation system is a mechanical system that maintains tire pressure at the optimum level for road conditions. In muddy, off-road situations the central tire inflation system maximizes traction by allowing the driver to adjust tire pressure from inside the cab.

The current fleet of 5,000 gallon semitrailer tankers can only go where their tractors can pull them. They do not have all-wheel drive and they have no reputation for off-road nimbleness. Their high center of gravity adds to their lack of mobility. The 5,000 gallon semitrailer tankers consist of a 5,000 gallon semitrailer "towed by a 5-ton, 6x6, M52 or M818 tractor truck or a similar tractor having a fifth wheel."[4] The M900 series 5,000 gallon semitrailer tankers are "designed for general highway and limited cross-country use."[5] The M131A5C, M131A5, M131A4C, and M131A4 series 5,000 gallon semitrailer tankers do not have the limited cross-country capability as the ones discussed above. Nonetheless, they do have load limits of 3,300 gallons when traveling cross-country.[6]

The 5,000 gallon semitrailer tanker maneuverability problems resurfaced during Desert Shield/Storm. Fixing the

problem in units included augmenting their fleet with the more maneuverable HEMTT tankers.[7] A similar problem may arise anywhere in the world where there is not a good highway infrastructure. Heavy traffic and poor weather conditions can quickly make any dirt road into a quagmire that is impassable by normal wheeled vehicles.

The 5,000 gallon semitrailer tankers' designs focus their use on paved roads or improved dirt roads. They have cross-country type tires, but their design does not allow them to spend many miles off improved roads. With no drive wheels or steerable wheels rearward of the tractor the trailer is at the mercy of the tractor and its strength. Most convoys do not move with a wrecker or more retrieval equipment than a mere tow bar, shovel, pick axe, and rope. When a 5,000 gallon semitrailer tanker and its prime mover get bogged down in the mud, this equipment connected to another prime mover (provided a winch is not attached to the stuck vehicle) can free the stuck vehicle. This vehicle does not have a mechanical means of getting itself free once it is up to its axles in mud. In unforgiving terrain it cannot conduct a lone fuel run to an outlying unit without substantial risk of becoming stuck or otherwise breaking down.

The M1062 series 7,500 gallon semitrailer tankers were built "to receive, transport, and discharge bulk fuel on improved roads."[8] This restriction, coupled with no organic pump for off-loading, makes the likelihood somewhat low that a M1062 will deliver fuel as far forward as the division area. The furthest forward this tanker will deliver is the corps rear in most situations. Therefore, this semitrailer tanker requires no further consideration.

The point is clear: PLS can go where 5,000 semi-trailer tankers cannot. PLS is highly mobile over rough terrain, unimproved roads, and in foul weather. Its greatest potential is its ability to move over unimproved roads made worse by rain or thawing snow. PLS can link-up with HEMTTs almost anywhere the HEMTT drivers want. The 5,000 gallon semitrailer tankers were designed for use on improved roads and were never intended for extended use over rough terrain.

C. Storage Capacity.

The current fleet of 5,000 gallon semitrailer tankers is designed to carry their capacity over all types of terrain. The only limitation that may be placed on their capacity is the ability of the tractor or prime mover. This may only occur with the M800 or M52 series

tractors being replaced by more capable tractors. A positive point about the current 5,000 gallon semitrailer tankers is that when one is full it can fill two empty HEMTT tankers without leftovers. This decreases safety problems associated with vapor in partially empty semi-trailer tankers and improves the semitrailer tankers' off-road maneuverability during backhaul. The capacity of the M900 series semitrailer tankers is a perfect match for the HEMTT tankers found in the maneuver brigades. I must mention that all 5,000 gallon semitrailer tankers cannot always carry 5,000 gallons. As noted earlier, the older series semitrailers (M131A series) can only carry 3,300 gallons during cross-country operations.[9] The older tankers are still around and they reduce our current capability to get fuel to the heavy division when and where the division desires. An M131A series semitrailer tanker making a delivery over rough terrain can only carry enough fuel to fill one empty HEMTT tanker and then have, at the most, only 800 gallons left for other deliveries. Therefore, I only consider M900 series tankers in this comparison.

The PLS tanker/trailer system described in chapter four contains two tankracks with 3,500 gallons capacity each combining for a total system capacity of 7,000 gallons. This quantity of fuel can be placed almost

anywhere the receiving unit wants delivery. A problem with the quantity of 7,000 gallons is that it does not divide evenly into the HEMTT tanker's 2,500 gallon capacity. The result could be a partial issue to a third HEMTT tanker or leftover fuel in the PLS tankracks. This does not pose a significant problem. The leftover fuel can be issued to vehicles for their immediate use. For example, the HEMTT tanker making a bulk fuel pick-up or the PLS truck retrieving the empty tankracks.

Despite the problems with having leftover fuel when delivering fuel using the PLS tankracks, the extra 2,000 gallon capacity per system provided by PLS is a definite advantage. The extra fuel deliverable where the tactical commander desires is a definite combat multiplier. The risk associated with partially empty tankracks is minimized with close management and attention to safety requirements by PLS operators.

D. Maintenance.

PLS advocates bill it as a system "designed for reliability, maintainability, availability, and durability."[10] During my discussions with an Oshkosh Truck Corporation marketing consultant I found that the PLS has greater than 45% repair part compatibility with the

current HEMTT family of vehicles.[11] This compatibility of parts with the HEMTT greatly improves our ability to maintain the PLS as it comes on-line to move ammunition on the battlefield. When (or if) PLS appears in U.S. Army units for petroleum distribution, many PLS systems will be on the battlefield and the accompanying history of repair parts usage will exist to support the system properly. With the hydraulic system, central tire inflation system, and the large tires/wheels the maintenance does not appear to be simple for the average driver or mechanic. For example, if a tire needs changing, the unit mechanics or the supporting maintenance unit will do the work. This is not simple for the driver with a mission to complete when he is not close to a maintenance facility.

The newness of PLS and its compatibility with HEMTTs will work together to overcome the inevitable problems with fielding a new vehicle system. There should be some mechanics with expertise on HEMTT repairs and the additional peculiar maintenance requirements associated with PLS should not be insurmountable. PLS truck/trailer systems are built by a company known for producing high quality and durable trucks. When the new wears off the PLS should still be a maintainable vehicle.

The 5,000 gallon semitrailer tankers are well established in the U.S. Army's maintenance system. Historical demand data exists on them and inventories are in place at every level to support them. The trailer is a rather simple design with few working parts. The lack of hydraulics simplifies required maintenance. The rather simple design, lack of moving parts, and diesel powered pump engine make the M900 series semitrailer tankers a non-maintenance problem. The interchangeable parts (wheels, tires, brakes, and suspension systems) between the M900 series trailers and the stake and platform trailers and container trailers enhances their supportability.

In this comparison the prime mover of the 5,000 gallon semitrailer tanker must be considered. The prime mover of these trailers can be one of several different models. The most modern of these is used throughout the Army to move all types of cargo. The benefits of maintaining a tractor established in the maintenance system have the same benefits mentioned earlier.

The largest drawback to maintaining the current system is the problems associated with age and equipment used for purposes (i.e., cross-country travel) it was not intended for. When this equipment goes off-road it is more vulnerable to wear and tear.

The current 5,000 gallon semitrailer tanker with prime mover offers a slight advantage in this category. Its simplicity and presence give it an advantage over the complex and new PLS system. I believe the Army will find the current system easier to maintain in the long term. The only way to change this finding is to prove that the PLS system has a significantly lower failure rate.

E. Simplistic Design (Operator Focused).

The one person delivery of PLS flatracks is a very simplistic method of delivering fuel. The driver finds the spot, drops his tankracks, reports his accomplishment, then scurries off to pick-up empty tankracks or whatever mission awaits him. The automatic transmission and central tire inflation system of the PLS simplifies the drivers tasks and enhances his opportunity to focus on more important tasks.

The most current tractors pulling 5,000 gallon semitrailer tankers have automatic transmissions that, as mentioned above, simplify the chore of operating the system. Trailer transfer operations can be performed by one person but they are simpler and safer when two soldiers work together to complete the task. Transloading of fuel from tankers to collapsible bags or other tankers always

requires at least three soldiers. Opening and closing the correct valves is not simple unless a trained soldier pays attention to the task.

The PLS is the simpler of the two systems to operate. No valves are involved and the operation requires no more than one person. How simpler can PLS be for the operator?

F. Airdrop Potential.

The PLS flatracks may prove themselves to be air droppable. Their potentially rugged design and self-contained pump and filter may make them the system of choice to be resupply heavy forces encircled by the enemy. A drawback will be retrieving the dropped tankracks for future use. The tankracks may prove to be a scarce resource like the five-gallon cans became in World War II. This will limit their use in those situations that make their return unlikely. In these situations, our current 500 gallon collapsible drums will perform the mission more efficiently.

III. Comparison of Applications.

A. Introduction.

The aim of this portion is to compare the current petroleum distribution system with the proposed PLS petroleum distribution system. The general method here is to look at the situation in the context of the offensive phases coupled with the essential elements of each phase (battlefield framework for the offense as it applies). In addition, I have added two situations when the heavy division has special fueling needs. These include task organizing a brigade into or out of the division and when the division, or one of its brigades, performs deep maneuver to execute corps level operations.

Doctrine concerning combat service support, particularly fuel support, stresses the importance of aggressive and timely service during the offense. Here is an excerpt from FM 100-10, Combat Service Support that illustrates this point.

> The fundamental principle of supply support is responsiveness to the user. Supplies must be provided when they are needed. Planning; coordination; communications; and, above all flexibility are key elements to be considered. Supply is more difficult in the offense than in the defense simply because of the ever-changing locations of units and their support areas. The concept of forward support becomes even more important and increasingly difficult in the

> offense. Likewise, CSS planners have to coordinate preparations with deception plans to avoid giving away the element of surprise. . . . The objective of CSS in support of offensive operations is to maintain the momentum by supporting as far forward as possible . . . . High fuel consumption will dictate that provision is made to build up quantities in forward locations - while avoiding signaling our intentions to the enemy - and ensure that Class III supply elements can move forward as the attack develops. . . . Class III bulk transporter assets throughout the theater must be intensely managed, particularly if the attack is highly successful and results in exploitation or pursuit. The attack and the general offense will require the most efficient use of fuel transporters from battalion to theater army levels.[12]

B. Preparation.

The preparation phase includes movement to contact and a meeting engagement. Movement to contact is the central feature of this phase and its purpose is to gain or reestablish contact with the enemy. The critical elements of movement to contact are security to the front and flanks, smooth and rapid deployment into the attack when contact is made, and prior coordination of supporting fires, both ground and air, to produce the fastest buildup of combat power at the decisive point. The overriding imperative of this effort is seizing and maintaining the initiative.[13]

To execute movement to contact successfully certain principles of movement to contact must be followed. One of

these principles is, "The force must move aggressively and with maximum speed. A slow or overly cautious advance will be dangerous, because slow-moving forces are easy to outflank or to target."[14] Aggression and maximum speed suggest that a high consumption of fuel is possible during movement to contact. FM 71-100, Division Operations, confirms this increased need,

> The movement to contact is characterized by increased consumption of petroleum, oils, and lubricants (POL), increased vehicular maintenance expenditure, and reduced ammunition expenditure. The speed of the operation and the high POL consumption necessitate careful planning of CSS. The division's CSS must be capable of sustaining uninterrupted movement.[15]

To maintain maximum speed and aggressive movement, the division must be refueled quickly at the proper time and place. Failure to do so may result in lost momentum and lost opportunities to seize the initiative. Properly located and timed refuel-on-the-move (ROM) operations can meet this need.

The 5,000 gallon semitrailer tanker provides 5,000 gallons if the roads to the area are improved. If the 5,000 gallon semitrailer tanker goes cross-country to reach the ROM site then the system's mobility over rough terrain hampers its movement. Currently, once operations move off improved roads then HEMTT tankers must take over the fuel storage requirement to operate ROM sites. PLS can perform

this mission efficiently and with increased quantity of product available on site with each system. This will free the HEMTT tankers for their best use: refueling forces in or near their battle positions. Actual operation of a ROM site requires the same number of fuel handlers despite the type of system operated.

PLS can deliver 7,000 gallons of fuel to almost any ROM site a HEMTT tanker can deliver to. A 5,000 tanker can deliver a substantial amount of fuel to ROM sites but only if the sites are close to improved roads. ROM sites that may be located on unimproved roads may not be accessible by today's 5,000 tankers. Improved mobility gives the PLS the ability to deliver substantial quantities of fuel to locations that were previously not accessible. In addition, vehicle operator requirements are reduced. Where before it took at least three HEMTT tanker operators to deliver 7,000 gallons, now this amount can be delivered by a minimum of one operator. This operator can help in the ROM operation, return to the bulk issue point to bring more fuel to the ROM site or other ROM sites, or perform other missions. The PLS tankracks can connect to existing ROM equipment and a ROM kit can be transported on the top of PLS tankracks if needed.

The meeting engagement is the climax of the preparation phase. Success in a meeting engagement includes, "Maintain(ing) momentum by synchronizing the actions of combat, combat support, and combat service support elements."[16] Combat service support functions must be performed without interfering with combat or combat support operations. To do this during this hectic period, fuel transporters must move aggressively and surefootedly to their destinations. Timeliness is essential. When called upon to deliver fuel the operator must deliver on time.

The mobility of PLS makes it a natural for these short notice, probably unreconned, missions. The mobility limitations of the 5,000 gallon semitrailer tankers make its use suspect. When tasked for such a mission the planners must consider terrain to decide likelihood of success. The last thing a combat commander needs to here is that he cannot continue an engagement because the fuel truck is stuck or broke down on a trail somewhere.

All the forces in the preparation phase conducting close, reserve, or rear operations move along at a quick pace. The forces conducting the deep and security/ reconnaissance operations advance at the same pace but do so with additional movement due to the nature of their mission.

C. Attack.

The attack phase includes either deliberate or hasty attacks. The difference between these is the level of planning, coordination, and synchronization associated with each. The hasty attack is more common due to the opportunity for them and the resources required for a deliberate attack.

> Attacks (arise) from a movement to contact, from a defensive posture, from behind a friendly defending force or during exploitation or pursuit. They may be part of a larger defense, such as counterattacks or spoiling attacks. Whatever its nature or purpose, the attack must be fast, violent, resolute, shrewd, and synchronized.[17]

The word fast when applied to an attack denotes the need to move quickly on the battlefield. This movement in a heavy division directly relates to the need for fuel. Throughout the battlefield units maneuver to exploit their positional advantage. The maneuver battalions engaged in close operations are constantly moving. They must be refueled efficiently by their HEMTT tanker operators so they can get back into the fight quickly. In turn, the HEMTT tankers must be replenished efficiently as well. For the HEMTT tankers to contribute to the operation they must be available to perform refuel missions. As HEMTT tankers are replenished closer to the maneuver units the more opportunity exists to exploit the shorter supply lines and to maximize the mechanized forces speed and maneuverability.

The lack of mobility and the need to make person-to-person contact when delivering limits the 5,000 gallon semitrailer tankers possibilities.

The PLS with its tankracks can make the most of these fluid situations. No longer will HEMTT tankers need to go back to the forward support battalions (FSBs) for fuel. With PLS the fuel can be delivered farther forward using caches or rendezvous. The mobility of the PLS allows it to move over inhospitable terrain at a quick pace and deliver fuel close to the fight. Therefore, PLS can serve as a combat multiplier when allowed to move fuel forward and reduce the HEMTT tankers driving time between issues.

Of course, given improved roads the 5,000 gallon semitrailer tankers can perform these forward missions in support of the close battle during the attack. These situations will occur where it can be employed, but the chances are great that there will be limited improved roads in the forward areas of our next battleground.

Units placed in the reserve must be prepared to move at a moment's notice to exploit success or reinforce a failing unit. In the attack the reserve force could be called upon to execute a turning movement or an envelopment due to a change in the expected course of the operation.

The possibilities exist that the attack may prove successful and assistance may be needed to exploit a penetration. These situations require a reserve force that is highly mobile and can move past the forward line of own troops (FLOT) and into the enemy's area. Sustainment to this force will necessarily be critical and perhaps difficult at best in these situations. Given improved roads and security the 5,000 gallon semitrailer tankers can support the reserve force in these situations. Without them the reserve force must rely strictly on its HEMTT tankers making the journey back to the closest fuel supply point to pickup vitally needed fuel.

During the attack, security and reconnaissance operations in the division are normally performed by the cavalry squadron, intelligence and electronic warfare units, and elements of the combat aviation brigade. Of these three the cavalry squadron poses the largest problem concerning refueling. The combat aviation brigade elements can return to forward area aviation refueling points in the aviation brigade support area, maneuver brigade support areas, or the division rear so this does not pose a special problem. The intelligence and electronic warfare units are not high volume fuel consumers. Their requirements can be met through helicopter delivery of 500 gallon collapsible

drums or five-gallon cans if fuel supply points are not located within their area of operations.

The cavalry squadron performs fast moving operations that requires them to cover lots of ground. They cannot be slowed by a logistics tail and must not be hindered by fuel distribution problems. Often they perform their security missions in inhospitable territory over extended distances. Their types of operations lend themselves to operating out of caches. These would consist of unmanned supply points at designated locations where supporters deliver needed fuel, ammunition, and other supplies. The 5,000 gallon semitrailer tanker does not lend itself to being left by itself in a cache. The PLS tankracks on the other hand are designed with cache operations in mind. They have a lower profile than the semitrailers and can be hidden more easily in most terrain conditions. The PLS caches can be positioned more places than a 5,000 gallon semitrailer tanker cache strictly due to mobility.

During the attack division level deep operations are executed by divisional artillery, the combat aviation brigade, (possibly) intelligence and electronic warfare units, and the Air Force through air interdiction and battlefield air interdiction sorties. Occasionally the cavalry squadron performs some type of deep maneuver. The

division artillery affects the deep operation from within the brigade rear boundaries. Therefore, the unit(s) with the deep operation mission is (are) supported with fuel on an area basis from a FSB or a special team from the ma' support battalion (MSB). The combat aviation brigade, intelligence and electronic warfare units, and the cavalry squadron conduct these operations in much the same manner, for support purposes, as discussed under the security and reconnaissance portion discussed earlier.

The focus of rear area operations during the attack is on keeping the supply routes and combat service support units operating and serving as combat multipliers. The 5,000 gallon semitrailer tanker is adequate for fueling this portion of the attack. The only advantage PLS tankracks would serve would be the one person exchange of tankracks.

D. Exploitation.

As the attack phase proves successful the offensive force moves into the exploitation phase of the operation. There is not always an easily discernible line where the attack stops and the exploitation phase begins. This is not a cause for concern because it is most desirable that

the offensive operation move from the attack into exploitation without pause. Doctrine dictates,

> Every attack not restricted by higher authority or lack of resources should . . . be followed without delay by bold exploitation designed to keep the enemy under pressure, compound his disorganization, and erode his will to resist. The ultimate objective of exploitation is disintegration of enemy forces to the point where they have no alternative but surrender or flight.[18]

The exploitation requires combat service support plans to be flexible. They must allow for extending lines of communications into areas previously held by the enemy. Fuel consumption will increase; therefore, plans must prepare fuelers to provide fuel forward rapidly.[19] As the exploiting force moves forward it may bypass some enemy units. These bypassed units are mopped up by follow-on forces. Combat service support forces must be aware of these enemy units and avoid them to accomplish the essential support tasks. This reduced level of security must be considered when placing fuel caches in the area. As in all operations, the tactical commander must be made aware of his logistical culminating points. Exploitation starts to stretch his lines of communications (LOCs) and the pace of the offense rises to a higher level than during the attack phase.

Close operation forces during exploitation move rapidly to meet the objective identified earlier. This

movement requires large quantities of fuel. The maneuver brigades will operate in an area recently held by the enemy. Mines and obstacles are likely. High speed avenues of approach may be mined, barricaded, and/or covered by fires. Currently 5,000 gallon semitrailer tankers cannot be counted on to traverse the rugged terrain and keep pace with the maneuver forces. Currently HEMTT tankers must break away from their battalions and go back to the fuel point. The longer the distance the HEMTT tanker operator must travel then the less time the tanker is available to fuel the fighting force. The PLS can set up these fuel points further forward than the 5,000 gallon tankers. Their better mobility, ease in being camouflaged, decreased manning requirement, and larger capacity make them a much better choice for the mission. Sometimes the PLS can replace the HEMTT tanker.

Reserve operations during the exploitation require their placement to be behind the lead exploitation brigades. They, or one of their elements, may be tasked with neutralizing bypassed enemy units. Nonetheless, the reserve's main mission remains being available to influence the outcome of the offensive operation. They must be able to move from behind and make calculated strikes against the enemy. This requires them to move at least as fast as the units in the close battle and most times even faster. For

the reserve to move and strike hard they must not be slowed by lack of fuel. The refuelers moving with them and supporting them must move quickly. Due to the need for decisive action by the reserve at times, the force must move across terrain that may not be supported by improved roads. This rapid movement over direct routes requires agile refuelers and bulk delivery close to engaged units. HEMTT tankers must get fuel to the force quickly so they can retain the initiative. The 5,000 gallon semitrailer tankers can provide this support but only if improved roads are available.

Security and reconnaissance operations are possibly at more risk during the exploitation phase than previously. The enemy may have better knowledge concerning the forces performing these operations and their locations. Except for increased risk and higher fuel consumption, security and reconnaissance operations are performed as they are during the attack phase.

Division level deep operations focus on elements of the division artillery and combat aviation brigade bringing fires to bear on the enemy's follow-on forces and support forces. The division's intelligence and electronic warfare units continue to collect information, disrupt enemy radio traffic, and perhaps support the division's deception

story. The fuel support required is essentially the same as in the attack but fuel consumption is higher.

The movement into what was previously the enemy's area places more risk on the division's rear area operation. Protecting the rear will increase in difficulty due to bypassed enemy units and possible indigenous people sympathizing with the enemy and waging guerilla warfare. This increased risk emphasizes the need units have for sound unit defense plans. As the risk to the rear increases, the support forces must be grouped together to maximize protection assets but they must not place all the division's supplies and support assets in one central location. If this is done it gives the enemy a prime opportunity to destroy the division's center of gravity: the combat service support force. The PLS tankracks can give the division more flexibility in dispersing fuel stocks. The tankracks are easier to camouflage than the 5,000 gallon semitrailer tankers. The racks can be cached, hidden, then secured with minimum manpower. Multiple caches in the division support area reduces the likelihood of destruction.

Exploitation and its stress on the logistical systems of the heavy division make knowing the unit's culminating point critical. The impairments of the 5,000

gallon semitrailer tankers limit the length of the LOCs. Their limit, which is usually where improved roads stop, must be made up by the HEMTT tankers. As long as the battle doesn't exceed the limit of these systems working together then the operation is safe. When the tactical situation requires more, then the culminating point is reached and trade-offs must be made. PLS can lengthen the LOC for DS tanker operations by extending past the improved roads and into the forward areas where roads may not exist or are in terrible condition. Extending LOCs and increasing the amount of product that can be delivered forward with one lift are two ways the PLS can extend culminating points. An extended culminating point equates to a heavy division more able to apply its full force during offensive operations.

E. Pursuit.

When the enemy breaks and runs the pursuit phase begins. This phase can follow either an attack or an exploitation. Its objective is annihilation of the enemy and is characterized by decentralized control and rapid movement. A major difference between exploitation and pursuit is that pursuit can rarely be anticipated and forces are not reserved for it, exclusively.[20]

In this chase to catch and annihilate the enemy, PLS benefits can be maximized. Its mobility over rough terrain, larger carrying capacity, ability to drop tankracks in designated locations, and one person operation make it a reliable system to fuel a force in the pursuit. These attributes can lengthen the LOC and extended the heavy division's culminating point.

The pursuit and exploitation phases are very similar. The only significant difference for fueling operations is that the pursuit has the potential to move at a greater pace. This increases the need for a bulk fuel hauler to be mobile and quick. To enhance the maneuver units' ability to fight, fuel needs to be pushed far forward. Current operations do not push fuel much farther than the brigade support area. The PLS can change this. It can go where the 5,000 gallon semitrailer tanker stops. It can keep pace with the HEMTT tankers and used to set up camouflaged fuel caches for future use.

Successful pursuit, as does exploitation, requires the heavy division commander to know the unit's culminating point. When operating in battle damaged enemy territory the virtues of PLS will take the heavy division further than the 5,000 gallon semitrailer tankers. The nature of the pursuit, unexpected and unplanned,

characterize it as an offensive phase that emphasizes continuity and responsiveness.

The pursuit takes advantage of the enemy breaking from contact and retreating. To be most successful, it must be executed without interruption. The system fueling it must deliver fuel as far forward as quickly as possible. Due to limited resources, caches and forward collapsible bag farms may be developed to avoid reaching the division's culminating point. The 5,000 gallon semitrailer tankers are good systems to charge fixed, manned facilities such as collapsible bag farms. It is not a good choice for caches that are not manned and are not along improved roads. PLS can best get fuel to the caches and perhaps to maneuver battalions if HEMTT tankers are unable to meet all retail fueling requirements. The PLS with its 7,000 gallon capacity, maneuverability, and on person operation make it a natural choice to fuel the heavy division during the pursuit phase of the offense.

F. Other Situations.

It is very likely that during AirLand Battle that the heavy division, or one of its maneuver brigades, will perform a turning movement as its portion of a corps operation. This deep maneuver requires a significant

logistical effort. Current deep battle support doctrine is limited. FM 71-3, Division Operations, also provides that,

> For the deep maneuver force to be most effective in a mid- to high-intensity environment, it should be a predominantly heavy combined arms force, large enough to defeat previously uncommitted enemy forces or to seize and hold a vital piece of terrain so that the close battlefield will be isolated.[21]

Supporting deep operations requires detailed planning and consideration. FM 100-10, Combat Service Support, lists two ways to support deep operation forces: self-sustainment and sustainment over LOCs.[22] Deep operations more than 24 hours in duration rule out the self-sustainment option. Therefore, our efforts focus on sustaining the deep battle over a LOC.

When the heavy division goes deep, the already strained distribution system becomes more stressed. The heavy division must receive additional support from the corps to be successful.

The 5,000 gallon semitrailer tankers can fuel the force if the roads are not too rough. The rougher the roads then the less they can deliver. On the other hand, the PLS tanker system can keep up with the fast pace of heavy division deep maneuver forces. It can deliver more product per system per delivery while the operators arrive in better condition to do their duty. With maneuverability

on a close par with the HEMTT tanker, it can supplement or replace the HEMTT tanker in many situations.

FM 100-10 offers the idea of "staging supplies near the FLOT."[23] This decreases the distance between the supply point and the consumer. The PLS tankracks are ideally suited for this type of operation. They can be placed along the FLOT in many different locations and are easily camouflaged. Since the tankracks deploy quickly and given their low profile they do not generate security requirements that 5,000 gallon semitrailer tankers do. The tankracks are set in place while the PLS truck and trailer are still available to perform other tasks.

In the case of a brigade performing deep maneuver and its self-sustainment, doctrine has this advice,

> . . . FSB assets may be used to augment the battalion support platoons. The tankers with drivers would be the most likely assets to augment the battalions though their maneuverability and survivability must be considered. . . . Planners must remember that the FSB's hauling assets are limited and have little off-road capability.[24]

When the brigade performing deep maneuver is sustained over a LOC fueling remains a concern. Doctrine advises,

> To support such operations the FSB itself will normally require additional support from the MSB or other division or non-division elements. This may include . . . additional 5,000-gallon tankers . . . fuel pumps and hoses to permit use of captured materiel.[25]

Deep operations are risky and dependent on the factors of mission, enemy, time, terrain, and troops (METT-T). Combat service support operations to support them are characterized by bold, innovative approaches.[26] PLS allows the sustainment planner and operator the most freedom and opportunity to support boldly and innovatively the division's deep forces.

When maneuver battalions are attached to a brigade then support requirements increase. If the FSB does not receive additional 5,000 gallon semitrailer tankers and operators then fuel support will lag. The additional resources will not come easily from the losing unit. They would like the resources to provide better support to their remaining force. With its focus on tankracks, one person deliveries, and caches the PLS system can handle these type of surge requirements with additional tankracks. This reduces the need for extra operators and prime movers. The cache system with one person delivery would be the rule in this situation.

Whenever the heavy division must provide a maneuver brigade under operational control (OPCON) to an adjacent division, the heavy division retains responsibility for support. This out-of-sector support requires close coordination between the adjacent division, the parent

division, the OPCONed maneuver brigade, and its habitual support elements. Out-of-sector support requires essentially the same considerations pondered during planning and execution of support for deep operations. The requirement for fuel depends on the type of operations conducted. Despite the total fuel requirements, the longer distances between the supported and the supporter require refuel operations to be efficient. As shown earlier, the PLS stands out as capitalizing on efficiency and maximizing manpower resources.

IV. Summary.

The PLS truck and trailer system with tankracks is overall superior to the 5,000 gallon semitrailer tankers currently fueling the heavy division. The PLS's mobility, one person operation, ability to split its load, and larger hauling capacity make it the system to fuel the heavy division on the AirLand Battlefield.

ENDNOTES

[1]Oshkosh Truck Corporation, "Oshkosh Truck Corporation Palletized Load System (PLS)," Oshkosh, WI, 1989.

[2]Waterways Experiment Station, Corps of Engineers, "Mobility Performance of the HEMTT and the Palletized Loading System (PLS)," memorandum dated 19 April 1991, Vicksburg, MS, 1.

[3]Waterways Experiment Station, "Mobility Performance of the HEMTT and the Palletized Loading System (PLS)," 19 April 1991.

[4]U.S. Army, FM 10-71, Petroleum Tank Vehicle Operations, (Washington: Department of the Army, 1978), A-2.

[5]FM 10-71 (1978), 3-1, 3-8, and 3-13.

[6]FM 10-71 (1978), 4-23.

[7]Peter S. Kindsvatter, "VII Corps in the Gulf War," Military Review, (January 1992): 8.

[8]FM 10-71 (1978), 3-55.

[9]FM 10-71 (1978), 4-23.

[10]"Oshkosh Truck Corporation Palletized Load System (PLS)," (1989).

[11]"Oshkosh Truck Corporation Palletized Load System (PLS)," (1989).

[12]U.S. Army, FM 100-10, Combat Service Support, (Washington: Department of the Army, 1988), 2-6, 2-7, and A-2.

[13]U.S. Army, FM 100-5, Operations, (Washington: Department of the Army, 1986), 98-99.

[14]FM 100-5 (1986), 112.

[15]U.S. Army, FM 71-100, Division Operations, (Washington: Department of the Army, 1990), 4-26.

[16]FM 100-5 (1986), 115.

[17]FM 100-5 (1986), 116.

[18] FM 100-5 (1986), 100.

[19] FM 71-100 (1990), 4-28.

[20] FM 100-5 (1986), 100.

[21] FM 71-100 (1990), 1-7 through 1-8.

[22] FM 100-10 (1988), 2-12.

[23] FM 100-10 (1988), 2-13.

[24] U.S. Army, FM 63-20, Forward Support Battalion, (Washington: Department of the Army, 1990), 2-14

[25] FM 63-20 (1990), 2-13.

[26] FM 100-10 (1988), 2-14.

CHAPTER SIX:

CONCLUSIONS AND RECOMMENDATIONS

I. Introduction.

This chapter provides a summation of the conclusions and recommendations generated by the previous chapters. Some recommendations and conclusions are obvious and others are not. The intent is for them to be logical and stimulating.

II. Conclusions.

The current 5,000 gallon semitrailer tankers providing direct support and general support level fuel support to the heavy division find it difficult to sustain the heavy division during aggressive offensive operations. These tankers were designed for use on roads; the heavy division conducts much of its operations beyond the limits of road networks.

Anticipation is the sustainment imperative most supported by PLS. It expands the planners' horizons and facilitates more options for meeting the force's needs; specifically, the ability of PLS to deliver fuel anywhere

on the battlefield and its affinity for security provides the flexibility planners need in a combat service support (CSS) system to anticipate requirements. Requirements in the form of positioning supplies forward of the forward line of own troops (FLOT) and to the rear of battalion task forces, while maintaining the brigade support area (BSA) class III supply points, are the results of this analysis.

Responding to these requirements is another PLS plus. Mobility and one-person deliveries allow PLS to react and position supplies anywhere on the battlefield quickly based on the combat commanders' offensive plan. Operators can quickly translate decisions into fueling orders which PLS can execute without haste and with leaders' confidence. Speed, mobility, and flexibility work together to provide a system that is highly responsive to force requirements in a dynamic environment.

PLS's ability to deliver its full load of fuel anywhere on the AirLand Battlefield makes it a superior system versus the current 5,000 gallon semitrailer tankers. The strengths of PLS allow it to deliver fuel farther forward. This flexibility creates opportunities to echelon from the BSA and operate from a forward BSA. The purpose of this forward BSA is to shorten the time that unit trains spend transporting supplies to combat units in

their fighting positions. This decreased transit time can result in more supplies delivered over a given period and a higher sustained rate of combat power. Additionally, the dispersion inherent to split-BSA operations enhances the security and protection of CSS assets as when executing hasty displacement.

The forward BSA with PLS capability makes echelonment of support a reality. The PLS can move into forward log bases without the need to stay on improved roads. The system operators can drop the full tankracks in the new forward logistics base while the operators with their trucks scurry back to a rendezvous point to get more full tankracks. Meanwhile, the heavy expanded mobility tactical truck (HEMTT) tanker operators can draw fuel from the tankracks on the ground.

PLS enhances refuel on the move (ROM) operations. PLS tankracks are easier to conceal and cover than 5,000 gallon semitrailer tankers. Increased capacity improves the endurance and flexibility of the site. PLS takes away the limitations imposed upon planners which are restrictions to good road networks and secure areas.

PLS improves the heavy division's ability to conduct offensive operations. Its largest contribution is

demonstrated during the phases of pursuit and exploitation. The high speed of movement, distances involved, terrain encountered, and amount of fuel consumed allow PLS to shine its brightest. The system's mobility, one-man operation, ruggedness, and large capacity mark it as the system to meet these fueling missions.

During the offense, heavy divisions require fueling systems that must follow task forces during all phases (preparation, attack, exploitation, and pursuit). This requires a system that best meets the sustainment imperatives (anticipation, responsiveness, continuity, integration, and initiative). The ideal system delivers fuel on demand wherever the customer wants. PLS is the closest system the U.S. Army has to an ideal system.

III. Recommendations.

I recommend that the U.S. Army outfit at least one active duty heavy division with PLS for fueling its forces. The division should be scheduled for National Training Center exercises so that the system can be evaluated and experience gained from its use in tough, realistic training. The National Training Center can validate the system's strengths and weaknesses.

I recommend that active studies directed by the U.S. Army, Office of the Deputy Chief of Staff, Operations, continue so that further uses for PLS are identified.

I recommend that the U.S. Army Training and Doctrine Command consider this thesis when recommending equipment authorization levels.

IV. Summary.

PLS is an equipment system that qualifies as a combat multiplier. It is the type of modern equipment the current Secretary of the Army and Chief of the Staff of the Army were referring to when they provided to members of Congress the enabling strategies that guide the U. S. Army in meeting the challenges of the future:

> To Maintain the Edge in warfighting that was demonstrated in Panama and the Persian Gulf by balancing the imperatives that ensure our success - quality soldiers who have been trained to razor sharpness, supported by dedicated civilian employees, outfitted with the most modern equipment, led by tough and competent leaders, structured in an appropriate mix of forces by component and type, and employed according to an effective warfighting doctrine.[1]

The palletized loading system is the way of the future in bulk petroleum distribution.

ENDNOTE

[1]Michael P. W. Stone and Gordon R. Sullivan, "Strategic Force - Strategic Vision for the 1990s and Beyond," A Statement on the Posture of the United States Army - Fiscal Year 1993," (presented to the Committees and Subcommittees of the United States Senate and the House of Representatives, Second Session, 102nd Congress): 8.

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